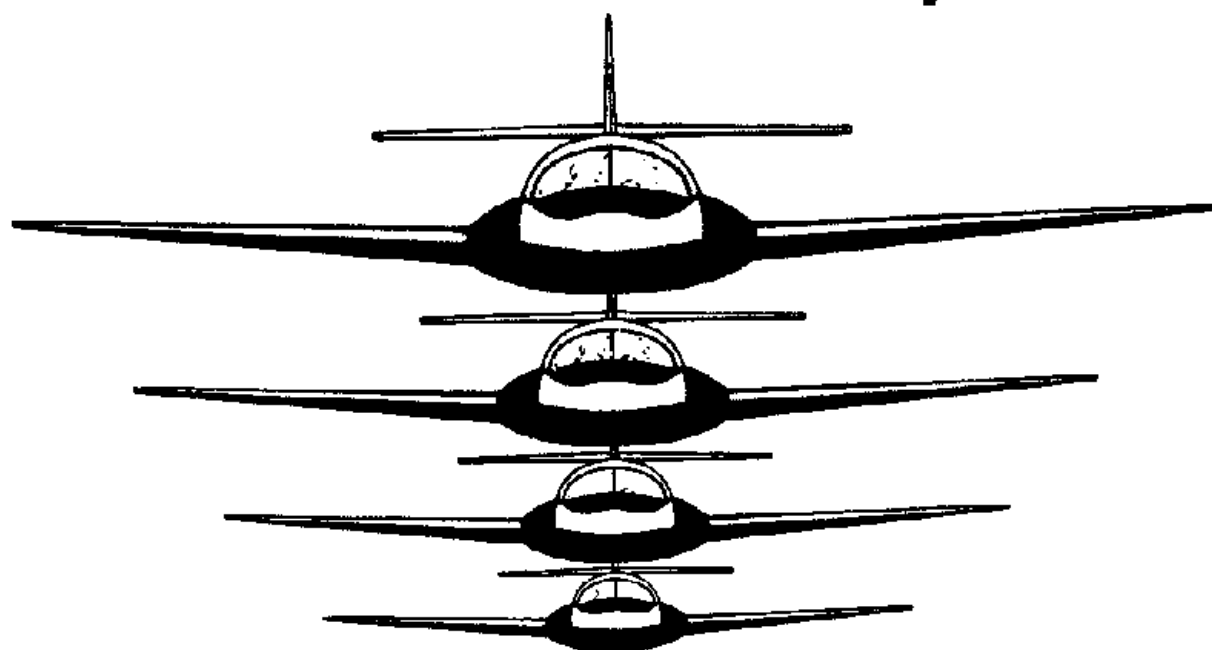




Air Force Functional Doctrine

MISSION EMPLOYMENT
PRIMARY FLYING, T-37



1 JULY 1993

CHANGES 1 & 2 POSTED

AIR EDUCATION AND TRAINING COMMAND

Air Force Functional Doctrine

MISSION EMPLOYMENT

PRIMARY FLYING, T-37

★This manual contains the basic principles and techniques that apply to all personnel operating T-37 aircraft under operational control of Air Education and Training Command (AETC). While the manual basically addresses the student pilot, all aircrew must understand this manual provides general guidelines for all T-37 pilots. Procedures for T-37 operations are contained in AETCI 11-201, *T-37 Aircrew Operational Procedures*. Procedural details and options are established in this manual and are referenced by the course training standards of various student pilot training syllabuses. When you encounter situations not specifically covered by this publication, use safety considerations as a guide in determining the best course of action. Procedural details of maneuvers as described in this manual may vary from those in other AETC publications. When differences exist, AETCI 11-201 and this manual take precedence. The 12 FTW and the 80 FTW will supplement this manual with procedures for their unique mission requirements. The 19 AF/CC must approve all supplements and supplement changes to this manual.

★Submit recommendations to change this manual on AF Form 847, *Recommendation for Change of Publication (Flight Publications)*, to 19 AF/DOV, 73 Main Circle, Ste 1, Randolph AFB TX 78150-4325. Attachment I contains an explanation of terms and abbreviations used in this manual.

SUMMARY OF CHANGES

Changes all "ATC" references to "AETC" or "19 AF" as appropriate. Incorporates recent changes to the T-37 flight manual concerning in-flight checks and critical action procedures. Clarifies when to accomplish an ops check (para 1.12.2). Adds definitions of joker (para 1.13) and bingo fuels (1.14). Corrects how much rudder pressure is required to maintain runway alignment as power is reduced (para 6.6.1.6). Deletes reference to a blindfold cockpit check before night flying because this check is no longer a syllabus requirement (para 7.1.2). Expands guidance on formation radio procedures (para 8.3.1). Clarifies formation call sign usage (para 8.3.2). Lists situations that may lead to knock-it-off calls in formation (para 8.24.1). Rewords general paragraph on extended trail (para 8.25). Rewords paragraph on performing a cuban eight during extended trail (para 8.25.2.4). Corrects figure 8.11. Adds a new section on fluid maneuvering to include a glossary of terms. (chapter 8, section D). Changes reference concerning the description on accomplishing a vertical-S (para 9.9). Changes reference concerning the description of an aileron roll (para 9.10.1). Changes reference concerning the description of a wingover (para 9.10.2). Adds a new chapter covering spin training to include the spin demonstration sortie and the spin checkout program (chapter 11).

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Chapter 1

GENERAL INFORMATION

1.1. Introduction. The objective of this manual is to provide techniques and procedures to aid you in becoming a professional pilot. To accomplish this goal, you must attain the highest degree of proficiency possible. This requires initiative, good judgment, trained reflexes, and skillful flying, which come only as a result of study, practice, and determination. The information you learn here will form the foundation for your military aviation career. Good study habits are essential. Every detail is important if you expect to be a safe, professional pilot. Some important information from other directives is included in this manual, but in no way is this information to be considered all inclusive. The majority of the skills and techniques you develop in pilot training will come from your assigned instructor, from other instructors you fly with, and through your experiences. As you gain experience and confidence as a pilot, you will also be developing your ability to use sound judgment. This manual and other directives are vital to flying operations. However, because of the many different situations you will encounter as a pilot, these directives can only provide a basis for good judgment. They do not replace it. The T-37 flight manual contains detailed instructions for inspections, checks, and procedures. Additionally, the T-37 flight manual provides valuable background information necessary to understand the aircraft systems and why procedures and checks have been established. This manual and the T-37 flight manual complement each other.

1.2. Briefings:

***1.2.1. Preflight Briefing.** Missions throughout the Air Force are preceded by a preflight briefing. Your instructor, a designated supervisor, or the aircraft commander will place special attention on crew coordination concepts and transfer of aircraft control during emergency situations. Briefing guides located in AETCI 11-201 list specific items to review in a preflight briefing.

1.2.2. Postflight Debriefing. After each flight, your instructor will review the mission. This review should clear up mistakes you may have made, but ask questions if you failed to grasp all the steps in any of the maneuvers. Becoming an Air Force pilot demands that you understand each lesson fully. Be sure you understand your mistakes and how to correct them. The time to ask questions is immediately after the flight, when your problems are still fresh in your mind.

1.3. Visual Inspection:

1.3.1. The preflight check starts before you reach the aircraft. Survey the taxi routes for any obstructions such as repair work on or near the ramp, stray equipment, or personnel who might be harmed by jet blast. A complete visual inspection of the aircraft is a very important part of each mission. Use particular care while checking the canopy jettison and ejection systems. All safety pins should be well seated.

1.3.2. The flight crew checklist is an abbreviated version of the flight manual a pilot uses to ensure procedures are followed. Refer directly to the checklist, and ensure all items are completed. You are not required to refer to the checklist to complete each individual item. For example, complete a few items and then refer to the checklist to ensure all items are properly completed. (*Exception:* It is not necessary to refer to the checklist during critical phases of flight.) Good checklist discipline is an integral part of military flying.

1.3.3. AFTO Form 781, AFORMS Aircrew/Mission Flight Data Document, is the official log of aircraft operation, servicing, and maintenance. The importance of checking this form can not be overemphasized. Report discrepancies, such as improper status or failure to sign off the preflight, to the line chief. Do not accept the aircraft until you are satisfied it is flyable. Definitions of the status symbols are inside the cover of the AFTO Form 781.

1.3.4. When checking oxygen quantity, ensure you have enough to complete your mission (300 pounds per square inch (psi) minimum for local sorties). The T-37 flight manual and flight crew checklist contain an oxygen duration chart to aid your decision. If you have any doubt about the oxygen quantity, have the oxygen system refilled prior to flight. Also, compare your actual oxygen with the AFTO Form 781. If you suspect a leak, check with maintenance personnel prior to flight.

1.3.5. Carefully check for fluid leaks in the wheel well, speed brake, and engine bay areas. These leaks are usually apparent from fluid along fairing doors, seams, and line couplings. Check the airlock fasteners closely. Note whether airlock fasteners are flush, check the alignment of their slots, and tap the access plate with your hand to detect looseness. Check the general condition of trim tabs, hinges, and control surfaces. Binding of the

controls and cracked hinges on control surfaces are reasons for rejecting the aircraft. Do not manhandle control surfaces. If you are not sure about the condition, setting, or operation of any single item, check with your instructor or qualified maintenance personnel. The pilot in command has final authority to accept or decline an aircraft.

1.3.6. Accomplish a postflight inspection of the aircraft following each sortie. The purpose of this inspection is to examine the general condition of the aircraft, not to accomplish any specific checklist. Look for any abnormalities requiring the attention of maintenance personnel, such as missing panels, damaged tires, or leaking fluids.

1.4. Position in the Aircraft:

1.4.1. Each time you fly, your seat position in the aircraft should be the same. Ask your instructor to help you determine the correct position. If seat adjustment is necessary during ground operation, install the seat pin before moving the seat adjustment lever. This will keep you from inadvertently raising the handgrips. In flight, be sure your feet are clear of the ejection handgrips and the proper lever is moved. Do not install the seat pins or attempt to hold the handgrips while adjusting the seat during flight.

1.4.2. Adjust the rudder pedals fore and aft with the rudder adjustment hand crank provided for each set of pedals. Adjust the rudder pedals to a comfortable distance. With your feet on the pedals, you should have full travel of the rudder and brakes.

1.5. **Interior Check and Starting Procedures.** On all dual flights, use the challenge and response system to check asterisked items in the checklist (parachute lanyards, oxygen, etc.). The items in your checklist are listed in an order that begins from the left of the cockpit and moves to the right. This system makes it easy to learn, and it reduces the margin for error. As in the visual inspection, consider each item as important as the next. If an item is overlooked, certain systems may become inoperative or damaged; therefore, reference the checklist to ensure all items are completed.

1.5.1. The importance of a thorough and proper oxygen system check cannot be overemphasized. A complete and unhurried check of this system is as important as any of your preparatory or in-flight procedures.

1.5.2. During engine start, while closely monitoring the engine's revolutions per minute (rpm) and exhaust gas temperature (EGT), occasionally

glance at the crew chief. He or she may give the first indication of anything unusual in your start. The canopy is normally fully open during engine start. When conditions dictate that the canopy should be closed during engine start, ensure it is fully closed and locked. Stow loose articles in the cockpit before starting an engine or opening the canopy with an engine running. Do not hand objects over the cockpit side unless the engine on that side is shut down and has stopped rotating. While taxiing, the canopy will be full up or down and locked. However, you may raise or lower it while taxiing.

1.6. **Instrument Cockpit Check.** Before flying, make sure each flight instrument and navigation aid (NAVAID) is working properly because you will need them to safely fly the aircraft in instrument conditions. In addition, AFM 51-37 requires a check of the equipment before flight. Checking the following items on your checklist will satisfy all requirements:

1.6.1. **Navigation Publications.** Ensure all publications required for your departure to destination and alternate are current.

1.6.2. **Pitot Heat.** Check for proper operation, including the heating of the stall warning transducer vane.

1.6.3. **Clock.** The clock should be running and the correct time set.

1.6.4. **Vertical Velocity Indicator (VVI).** The pointer should be at zero.

1.6.5. **Attitude Indicators.** These should be erect with the bank pointer aligned with the zero bank index. No warning flags should be visible. Set the miniature aircraft on the horizon with the pitch trim knob.

1.6.6. **Magnetic Compass.** Check the accuracy of heading information.

1.6.7. **Heading Indicators.** Check the accuracy of heading information. Look for correct movement in turns.

1.6.8. **Airspeed Indicators.** Check the pointers and rotating airspeed scale for proper indications.

1.6.9. **Altimeters.** Set the current altimeter setting. The maximum error of each altimeter at a known elevation point is 75 feet. The 10,000, 1,000, and 100 counter-drum pointers should indicate the appropriate elevation.

1.6.10. **Very High Frequency Omnidirectional Range (VOR) Check.** Tune and identify the station (all off flags should be out of sight). If you have

a reliable signal, perform the self test or the ground check. (If either check is out of limits, consider the VOR unreliable.)

1.6.10.1. VOR Self-Test. Place 315° in the course selector window, and press the VOR/ILS test button. The course deviation indicator (CDI) will center within $\pm 2^\circ$, the bearing pointer should indicate 315° with a TO indication, and the marker beacon light will illuminate. If the VOR self-test functions properly, a check of the VOR at the designated ground checkpoint is optional. However, it is important to use all available information when checking NAVAIDs, especially when weather conditions are marginal.

1.6.10.2. VOR Ground Check. Tune and identify the station. Ensure the bearing pointer points to the station. The allowable error at the ground checkpoint is $\pm 4^\circ$. Check that the CDI centers within $\pm 4^\circ$ of the designated course. Rotate the course set knob, and check for proper CDI displacement. Rotate the course select knob, and check that the TO/FROM indicator changes when the selected course is approximately 90° to the bearing pointer.

1.6.11. Distance Measuring Equipment (DME) Check. Tune and identify the station. Perform the self test.

1.6.11.1. AVQ-75 only. Turn and hold the DME selector to test. The DME should increase to and stop at 196, and the range warning flag should go out of view. Release the selector to the DME position. The DME should return to the approximate distance from the station.

***1.6.11.2. AN/ARN-154(V) only.** The DME will self test when power is applied or by momentarily holding the selector to test. The self test will conclude with a display of either SELF TEST PASS or SELF TEST FAIL. The DME should return to the approximate distance from the station.

1.6.11.3. DME Ground Check. Check the DME at the ground checkpoint (if available). The range warning flag should be out of view, and the distance indicator should be within $\frac{1}{2}$ mile or 3 percent of the distance to the facility, whichever is greater.

1.6.12. Instrument Landing System (ILS). If a valid ILS frequency is received, the ILS self-test may be used. With the localizer identified, check for no OFF flags, absence of TO/FROM indication, and proper needle deflection in relation to aircraft position. The radio magnetic indicator (RMI) bearing pointer should park at the 4-o'clock

position. Pressing the VOR/ILS test button will illuminate the marker beacon light.

1.6.13. Turn-and-Slip Indicator. Check to ensure each needle indicates proper movement in a turn and each ball is free to move in its glass tube.

1.7. Taxiing. The T-37 is equipped with nose wheel steering to turn the aircraft while taxiing.

1.7.1. After the before-taxiing checks, visually clear to the front and rear. Increase power as necessary, depress the steering button, and release brakes. Pick up momentum straight ahead, simultaneously apply rudder in the desired direction of turn, and reduce power (normally to idle). Avoid the tendency to neutralize the rudders just as the aircraft starts turning. This will merely straighten the nose wheel, necessitating the application of rudder to put the aircraft back in the turn. If you need a sharper turn than can be made with the steering mechanism, release the steering button and use the brakes to establish the angle of turn desired. When you do this, keep the inside wheel rolling. Any attempt to pivot the aircraft on a locked inside wheel will damage the wheel, tire, and strut. This is particularly dangerous because the damage may not be apparent, but the gear may be damaged enough to collapse under the strain of landings. To make sure the inside wheel rolls, release the inside brake intermittently. Apply the brakes smoothly, evenly, and cautiously at all times. When leaving a parking area, be especially alert for aircraft taxiing past your position. Also watch for personnel, ground equipment, etc.

1.7.2. When clear of the parking area, use power as needed to keep the aircraft rolling at a moderate speed. Nose wheel steering will be more sensitive as taxi speed is increased. Use the brakes as sparingly as possible to prevent excessive wear and overheating. Keep taxi time to a minimum because of the high rate of fuel consumption. While taxiing, do not perform checks until the aircraft is in an unobstructed area. Do not concentrate all your attention inside the cockpit.

1.7.3. Do not taxi aircraft with less than 10 feet of clearance from an obstacle. Do not taxi without a wing walker when an obstacle is between 10 and 25 feet from the aircraft. This requirement is waived for locally based aircraft if established taxi lines are marked and obstructions are either permanent or other aircraft parked on established parking spots. Spacing between taxiing aircraft must be a minimum of two ship lengths when staggered in trail. If you must taxi directly behind an aircraft, increase the spacing to a minimum of four ship

lengths to avoid exhaust fumes and foreign object damage (FOD).

1.7.4. Exhaust gases contain harmful quantities of carbon monoxide—an odorless, but toxic, gas. Use 100 percent oxygen to prevent breathing these gases. When the aircraft ahead of you has cleared, reset your oxygen to normal. Your oxygen supply will be depleted prematurely if the regulator is left on 100 percent for the entire flight.

★1.8. **Radio Procedures.** Under normal operations, radio voice communications should be kept to a minimum. A call to the tower for taxi instructions serves as the radio check. Remember, when the mike button is depressed, the entire channel is blocked for other aircraft. Do not depress the mike button during another aircraft's transmission. If a transmission is being made by another aircraft, anticipate an answer to the radio call and do not break in. Make sure the radio is on and the proper channel is selected. Do not use the tone button for this purpose. A general format for professional radio communications is to broadcast who you are talking to, who you are, where you are, and what you want to do. It is imperative that your message be both clear and concise. Organize your thoughts, depress the mike button, say what you intend to say, and get off the air. Do not transmit when another aircraft is in a critical phase of flight (such as in the flare).

1.9. Clearing:

1.9.1. When clearing, ensure your intended flight path is well clear of other aircraft. The type of clearing will depend upon the maneuver, the configuration of the aircraft, and other flight planning factors. Be aware of the restrictions to visibility created by your position in the cockpit, the canopy bow, canopy rails, and the other pilot's seat. Focus your eyes on a distant point, and use various search patterns (vertical, horizontal, etc.). Visual search must become a definite pattern instead of random looking. Constantly practice your search technique.

1.9.2. All aircrews operating in visual meteorological conditions (VMC) must maintain a constant vigilance for other aircraft. The use of radar monitor or assigned areas does not relieve you of the responsibility to clear. An instrument flight rules (IFR) clearance only separates you from other known IFR traffic. Some maneuvers in the area are good clearing maneuvers; others may require a clearing turn or "whifferdill" type of maneuver to adequately clear.

1.9.3. You can help yourself remain clear of local traffic by knowing areas of possible conflict. Be aware of the location of the departure and recovery routes, flying areas, and traffic patterns. Emphasize clearing in these directions. Listen for radio transmissions to help you track traffic in your vicinity. The more you know about your immediate flying environment, the better you will be able to detect and avoid other aircraft.

1.9.4. Area procedures and radio transmissions are only part of the overall effort to avoid other aircraft. The most important ingredient is your ability to visually detect each aircraft. Aircraft unfamiliar with the training areas and routing may fly through your airspace, so be alert.

1.10. **Wake Turbulence.** All aircraft generate wake turbulence, and the T-37 is very susceptible to wake turbulence. When such turbulence is anticipated, proceed with extreme caution. Do not depend solely on a controller to advise you of the possibility of encountering wake turbulence. Remember, the controller may provide wake turbulence separation, which may not be adequate in all situations. It is your responsibility in each case to ensure proper separation on the approach. Be especially aware of the possibility of wake turbulence during takeoff, approach, and landing. When you anticipate the possibility of wake turbulence, remain upwind of the preceding aircraft's flightpath to keep you clear of that aircraft's wake turbulence. Flying a nonprecision approach will very likely place your aircraft in the area of wake turbulence generated by an aircraft on a precision glide path. If you are unable to remain above the aircraft's flightpath, consider increasing your spacing or going around. Use caution when going around from below the preceding aircraft's flight path because you may fly through that aircraft's wake turbulence.

1.11. **Takeoff and Landing Data (TOLD).** On every flying mission, you will be taking TOLD to the aircraft. Initially, you will find the information at the duty desk or in the flight room. However, before solo you will be required to compute this information and understand how to apply the numbers. This information becomes even more important when you are flying from unfamiliar airfields because temperatures, pressure altitudes, and runway conditions may be significantly different from your home field.

1.12. In-Flight Checks:

1.12.1. On dual sorties, use the challenge and

response system to confirm accomplishment of all asterisked checklist items.

1.12.2. An ops check should be accomplished when passing 10,000 feet MSL, when reaching your final cruise altitude, and approximately every 15 minutes thereafter. You may combine ops checks if your final level off altitude is at or below 14,000 feet MSL. Additionally, if accomplishing multiple VFR patterns or instrument approaches, periodically accomplish an ops check. (It is not necessary to check your oxygen system during these ops checks.)

1.13. **Joker Fuel.** Joker fuel is the prebriefed fuel needed to terminate an event and proceed with the remainder of the mission. An example is terminating area work to accomplish a recovery for multiple patterns.

1.14. **Bingo Fuel.** The aircraft commander will brief a bingo fuel for every mission. This fuel allows you to fly the planned recovery route and land with an appropriate fuel reserve. Because bingo fuel allows only one pattern and landing, you must initiate a recovery no later than bingo fuel.

1.15. Transfer of Aircraft Control:

1.15.1. During flight it is important to know who has control of the aircraft. When you are flying, stay on the controls until told otherwise. During transfer of control, the pilot relinquishing control will say "You have the aircraft." The pilot assuming control will say, "I have the aircraft," and will shake the stick noticeably. It is not important who speaks first, but both pilots must verbally acknowledge the transfer. During critical phases of flight, relinquish the controls immediately on your instructor's verbal command so you will not obstruct any flight control or throttle movement.

1.15.2. Your instructor will brief you on your responsibilities and how you will assist in unique situations such as interphone failure or aircraft malfunction. Remember, if you are flying, stay on the controls until you know your instructor has control of the aircraft. If warranted and time and conditions permit, your instructor may give you verbal assistance.

1.16. Student Responsibilities:

1.16.1. The undergraduate pilot training (UPT) program is designed to graduate professional military pilots. Organizing and planning are major keys to fulfilling this objective. Your part of this process is to ensure you are properly prepared for the flight line, are well nourished, and have received adequate rest.

1.16.2. Each day when you report to the flight line, be prepared for any type of mission. This means more than simply reading about the maneuvers in this manual. You should know all the procedures for a given maneuver and be able to state the sequence of actions. Many students find that chair flying is a helpful technique in preparing for a mission. Basically, this means you organize a mission profile and then simulate the flight mentally, reviewing each item you must do. Remember, your time in the aircraft is limited. If you prepare properly on the ground, you will be able to spend your airborne time more profitably.

1.17. **Flying Safety.** Flying safety is more than merely a set of practices or a particular safety record; it is an attitude. You should continually evaluate your performance by asking, "Did I perform that activity in a professional, disciplined, safe manner?" Do this from the time you start planning a flight until you finish debriefing. One of the greatest hazards in today's flying is the potential for a midair collision. Your best defense is to see the other aircraft first. Aggressively clear the airspace around you, using the techniques your instructor will show you.

1.18. **Ground Safety.** The flight line is a hub of activity. Consequently, this calls for extra attention on the part of everyone who is required to be there. When you are on the flight line, you must wear approved devices to protect your hearing against the harmful noise of the T-37 engines. Because this protection will block out some of the other sounds that might warn you of danger, you must constantly be alert for hazardous situations. Stay clear of aircraft jet blast. Also use caution when walking in front of jet engines because loose objects may be drawn into the intakes.

Chapter 2

BASIC PRINCIPLES OF FLIGHT

2.1. Effects of the Controls. Each flight control has its effect on the attitude of the aircraft and controls the movement about one of its three axes (figure 2.1). You should learn these effects in order to control the aircraft and obtain the desired responses. Your instructor will demonstrate the use and effects of the controls, first in straight-and-level flight at cruising airspeed and then in other flight attitudes. The same predictable responses to control movements will result regardless of the attitude of the aircraft. Think of yourself as the pivot point about which all changes of attitude occur.

2.1.1. Pitch. Moving the stick forward and aft (fore/aft) controls the aircraft's pitch (movement about the lateral axis). To achieve level, climbing, or descending flight, hold the nose of the aircraft in a fixed position relative to the horizon. You can use many other outside references to determine pitch attitudes, such as the position of the wingtips or the glare shield in relation to the horizon. You can also check the desired pitch attitude by reference to the flight instruments. Your instructor will show you the outside and instrument references

for climbing and descending flight. Continuous cross-check of all pitch references will result in better control of the pitch attitude of the aircraft.

2.1.2. Yaw. Yaw is movement about the vertical axis. When yaw exists, the ball in the turn-and-slip indicator is displaced from center. Also, yaw causes your body to lean toward one side of the cockpit like when you round a corner in a car. Coordinated flight should be free of yaw even in a steep bank. When the aircraft is coordinated, your body retains a comfortable, upright position. The proper use of rudder is essential for coordinated flight.

2.1.3. Roll. Rotation about the longitudinal axis is caused by the lift differential created as aileron surfaces are moved out of the streamlined position of the wing. The wing with the raised aileron goes down because of decreased lift, and the wing with the lowered aileron goes up because of increased lift. The effect of either aileron is augmented by the simultaneous and opposite movement of the aileron on the other wing. In level flight, moving the control stick toward a wing raises that wing's

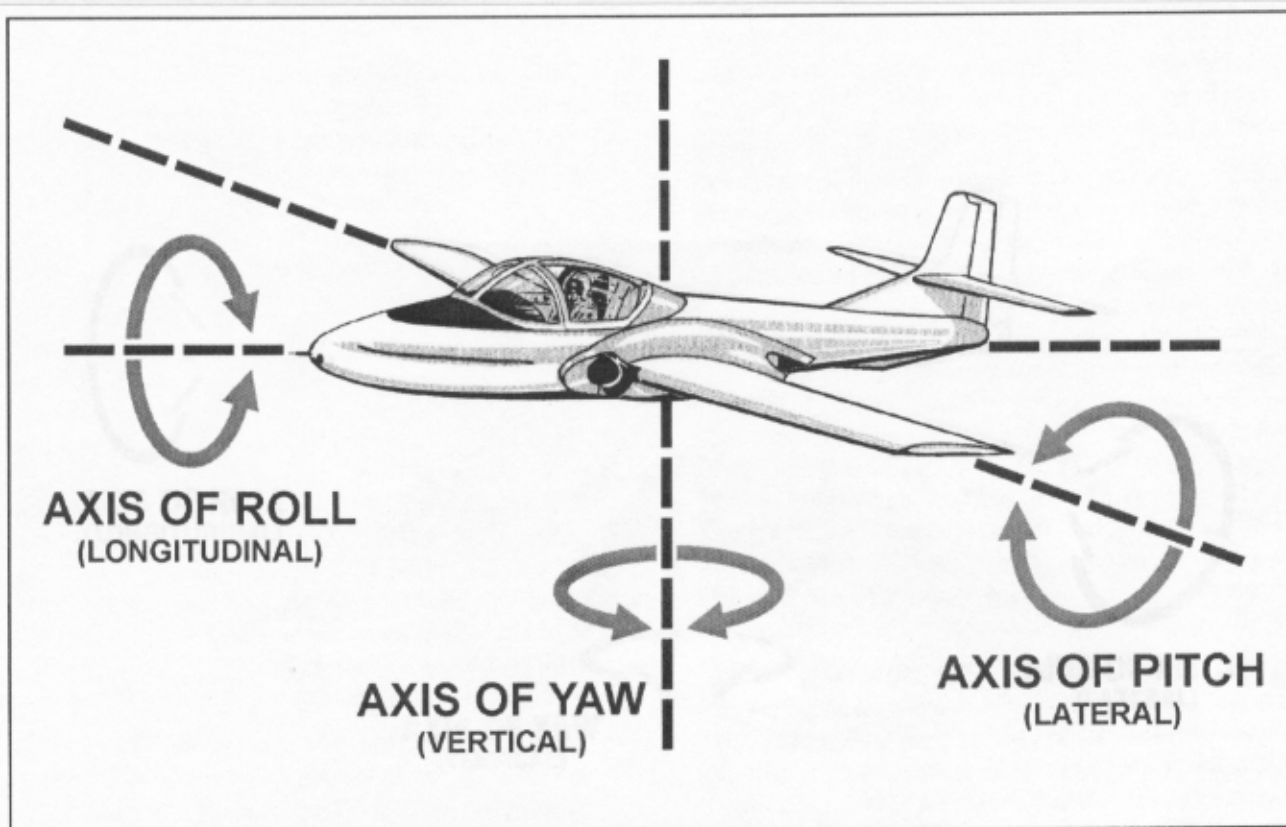


Figure 2.1. Axes of the Aircraft.

aileron surface, causing the wing to go down and the aircraft to roll in that direction. Simultaneously, the other wing aileron goes down, causing the wing to go up.

2.2. Adverse Yaw:

2.2.1. The movement of the aileron surfaces out of the streamlined position creates drag. This drag is not distributed equally on each aileron; the down aileron (on the up wing) produces the greater drag. When this condition exists, the aircraft does not turn immediately in the direction of aileron movement but tends to turn the opposite way. There is a difference in the curvature of the upper and lower surfaces. The bottom is fairly straight, but the top is distinctly curved. Bernoulli's theorem states that the difference in airflow speed over the surfaces must result in a difference in pressures and the higher static pressure area will be along the bottom surface.

2.2.2. When you use ailerons to bank an aircraft, the aileron that goes down extends into the area of greater static pressure, increasing drag. Due to the shape of the wing, the aileron that goes down also increases the positive camber of that wing, increasing both lift and induced drag. At the same time, the aileron that goes up on the opposite wing decreases the positive camber of that wing, reducing lift and induced drag. This combination of factors causes the aircraft to tend to yaw in the opposite direction while the banking action is taking place. This adverse yaw tendency continues until the ailerons are neutralized.

2.2.3. Adverse yaw is most apparent at low airspeeds and extreme control-surface deflections. At low or near-stalling speeds, adverse yaw is very noticeable; at high speeds, it may not be noticeable at all. This is true because the movement required of the aileron surfaces is greater at lower speeds. The ailerons must be moved farther from the streamlined position to cause an appreciable alteration of lift in the slower slip stream. The higher the angle of attack (AOA), the greater the pressure on the bottom side of the wing (until the stalling speed is reached and the airflow disrupted). At high speeds a small airstream alteration generates more lift than in a slower airstream; therefore, less aileron is needed to lift the wing.

2.2.4. Adverse yaw can be overcome by using the rudder. As you apply right or left aileron pressure, simultaneously apply rudder pressure on the same side. Use rudder pressure as long as the bank is changing. The correct amount of rudder pressure depends on the aircraft speed and the amount of aileron used. Keeping the ball centered in the turn-

and-slip indicator is a guide to using the correct amount of rudder. Remember to use rudder and aileron pressure simultaneously, although the required amount of pressure will differ depending on the amount of aileron used, the airspeed, the effect of drag, and the design of the particular aircraft you are flying. Also remember, the aileron drag effect is present during recovery from a turn as well as during the entry. The rudder must again be used in the same direction as aileron stick pressure to counteract adverse yaw.

2.3. Use of Controls. When a control surface is moved out of its streamlined position, the air flowing past it will exert pressure against the control surface and try to return it to the streamlined position. It is this pressure you feel on the stick and rudders. The amount of pressure you feel is determined by the airspeed and the degree the control surface is deflected. The higher the airspeed the greater the pressure.

2.3.1. **How To Use the Rudder.** Position your feet comfortably with all the weight on your heels. Let your heels rest on the cockpit floor with the balls of your feet on the rudder pedals. When you use the rudder, apply pressure smoothly and evenly by pressing with your foot just as if you were using the brakes of an automobile. Don't let your legs and feet become tense, but stay relaxed so you can feel rudder pressure.

2.3.2. **How To Use the Stick.** Generally you should hold the stick lightly, the same way you would hold the steering wheel of an automobile—relaxed and comfortable. Some maneuvers, such as aerobatics, require more positive pressures. Let your arm and hands relax so you can feel the counterpressure from the stick, but always control the aircraft. Never let it control you.

2.3.3. **How To Use the Throttles.** Normal throttle movement should be slow at low rpm with the rate of movement increased as the engine winds up. You can advance the throttles more rapidly at higher rpm. As a guide, move the throttles at a rate slightly faster than engine acceleration. When time is critical (low altitude, thrust deficient situations), rapid throttle movement is the most effective procedure to achieve maximum engine acceleration. Acceleration time is approximately 40 percent less when accelerating from 50 percent rpm to military power versus idle to military power.

2.3.4. **Coordination.** The effect of each control has been discussed individually, but you should realize that no single control movement provides all the control for a maneuver. To fly your aircraft efficiently, you must use the controls together. This

is known as coordination of controls and is vital to smooth flying. After you know how the aircraft will react when the controls are used, you must learn how to use them properly. Rough, erratic use of any of the controls will cause the aircraft to react accordingly, so it is important that you apply the pressures smoothly and evenly.

2.4. Composite Flight. Composite flight requires the use of outside references supported by flight instruments to establish and maintain desired flight attitudes. You will use composite flight throughout your flight training.

2.4.1. All maneuvers are accomplished by establishing attitudes and progressively changing these attitudes throughout various stages of the maneuvers. Establish and maintain an attitude by positioning the nose and wings of the aircraft in relation to the horizon. Very small changes in attitude may not be readily noticed by outside reference to the Earth's horizon, but will be indicated by the flight instruments. Be careful. Depending solely on your instruments has several disadvantages. The most serious is the inability to observe aircraft and other hazards to flight.

2.4.2. A good composite cross-check is necessary to ensure precise flying. Let the conditions dictate where you direct your attention. As the visibility deteriorates, increase the use of flight instruments. Develop your cross-check so all necessary information is obtained at a glance. Always maintain vigilance to avoid midair collision and to remain oriented. Do not concentrate on any one reference. You must maintain a constant vigilance for other aircraft. Check your reference, make a correction, look around, cross-check other references, and then return to the original reference, using all of the references to confirm the accuracy of your control pressures or the need for a further correction. This process is continually repeated in composite flying.

2.5. Trim. When you consider all the factors that affect the aircraft in various conditions of flight, the need for trimming becomes apparent. Considerable force is required to hold the correct elevator control pressure for level flight with high airspeed. Flying would be very tiring if some means were not available to relieve these pressures.

2.5.1. The trim tabs act as levers and equalize the pressures exerted on either side of the parent control surface. To equalize pressures, the tabs are moved in an opposite direction from the parent control (figure 2.2). If the rudder is not trimmed properly, the aircraft will fly in a skid as indicated

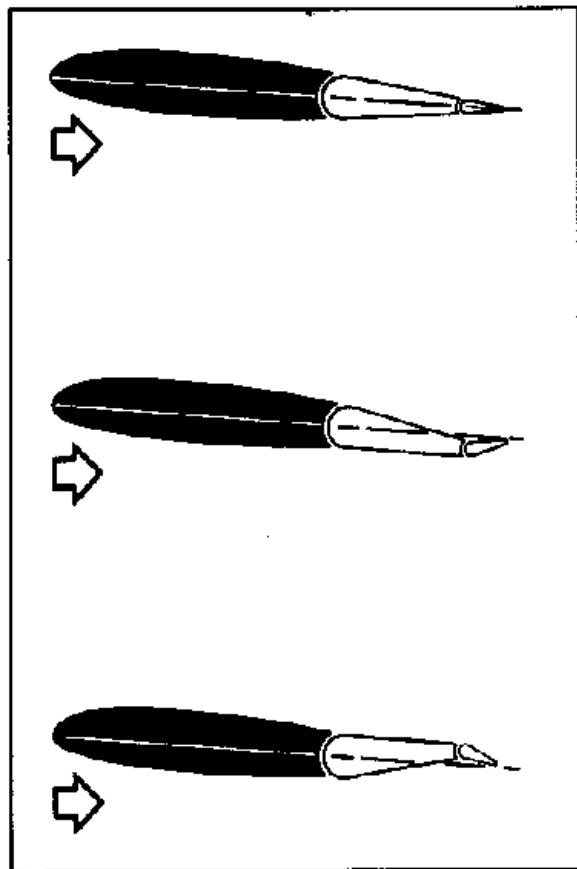


Figure 2.2. Trim Tabs—Aids to Smooth Flying.

by the turn-and-slip indicator. The ball will be deflected while the needle is centered. To correct this condition, apply rudder to center the ball (while holding the turn needle centered) and relieve the pressure with rudder trim. To correct wing heaviness or rolling tendencies, adjust the aileron trim. When the pressures on the controls have been relieved, the aircraft is correctly trimmed.

2.5.2. Since the trim tabs on the T-37 are all electrically operated, it is possible for any one of them to run away in flight because of inadvertent actuation, a stuck button, or a short in the system. Always trim in short clicks and avoid inadvertent trim actuation.

2.5.3. In the T-37, power changes normally do not require large, immediate changes in control pressures. The need for trim, therefore, is evident only gradually as the airspeed changes. Always think of trimming as a recurring process.

2.5.4. There are other devices controlled by the pilot that also affect the aircraft. These are the flaps, landing gear, speed brake, and thrust attenuators. However, these all have other primary purposes and their effect on aircraft control is incidental. Trim will compensate for these minor effects.

2.6. Straight-and-Level Flight. Your objectives in this training exercise are to learn the use of the controls, to combine the use of outside and instrument references for maintaining aircraft attitude, and to learn to divide your attention by constantly checking all available references without concentrating on any one.

2.6.1. Flight Instruments. Before practicing straight-and-level flight, you must be familiar with the flight instruments. You must understand the effect and use of the controls, and you must be relaxed and properly seated in the aircraft.

2.6.1.1. The approximate power setting for normal cruise straight-and-level flight is 90 percent. Attaining level flight is a matter of consciously fixing reference points on the aircraft in relation to the Earth's horizon and comparing or cross-checking this relationship with the flight instruments. The instruments you refer to for control of pitch attitude are the attitude indicator, altimeter, VVI, and airspeed indicator.

2.6.1.2. Your instructor will show you each instrument's indication in conjunction with outside references. Do not concentrate too much on one reference or stare at a particular reference. This will not only hinder your progress, but will create a dangerous situation because you will not be clearing for other aircraft. Check each outside and inside reference in turn, and use each for minor control adjustments. You must have a thorough knowledge of the design, location, and information presented by all instruments. Familiarity with these instruments and outside references enables you to determine the control pressures necessary to control the attitude and the direction of the aircraft. Control pressures should be smooth and applied with confidence. The beginning student often over controls from lack of experience, but this tendency can be minimized through practice of smooth application. Good control is a continuous succession of minor, almost imperceptible corrections to keep the aircraft in the desired flightpath.

2.6.2. General. After you have had a little practice in straight-and-level flight and have learned to check all your references properly, you can establish the correct level flight attitude in a few seconds. You will learn to look around quickly and establish pitch, bank, and direction simultaneously. Power changes and trim technique will become second nature. A trim change is necessary when you are having to hold continuous stick or rudder pressure to maintain the desired flightpath.

2.6.2.1. The weight of your right arm on the stick may cause the ailerons to be slightly displaced,

which will result in flying with the right wing low. In most cases, this will cause a very slight turn to the right. To keep the aircraft from turning, you would have to use a steady left-rudder pressure, but this would set up an undesirable cross-controlled condition. The solution is to place the weight of your right arm on your thigh, which will reduce any tendency to be heavy handed. Remember to check your references frequently to determine any tendency toward heavy-handedness.

2.6.2.2. A common student error is the tendency to stare at the nose of the aircraft and attempt to hold the wings level just by observing the windscreen in relation to the horizon. This will not work, particularly in the T-37 which has a rounded glare shield. It may result in flying with one wing low. This wing-low attitude requires the use of additional rudder to maintain straight flight and gives a false conception of neutral control pressures as well as an uncomfortable seat position. This is another case of what can happen if you do not continuously cross-check all references.

2.6.2.3. Let your eyes sweep along the horizon, picking up the wingtips, and make a mental note of required corrections. At the same time, look for other aircraft that might be flying in your area. Make your corrections, and return to inside references to confirm them. Then look outside again in a continuous process. Soon it will become second nature and effortless.

2.6.2.4. Straight-and-level flight requires almost no pressure on the controls if the aircraft is properly trimmed and the air is smooth. When you are flying through turbulence, the flight attitude may change abruptly. Do not fight the controls to stop these changes. Ride them out like a boat on a rough sea, and make smooth but firm adjustments as needed.

2.7. Turns. Use a turn to change the direction of the aircraft. It involves the close coordination of all three controls; ailerons, rudder, and elevator. Since turns are incorporated in almost all aircraft maneuvers, it is important that you learn to perform them well. The shallow turn is a turn of approximately 30° of bank or less. The steep turn is a turn of approximately 45° to 60° of bank.

2.7.1. Before beginning any turn, look in the direction of the turn to clear above, below, and at your flight level. You do this to make sure the area is clear of other aircraft. Once you have cleared the area, simultaneously apply pressure to both ailerons and rudder in the direction of the turn. This pressure will move the control surfaces out of their streamlined position and cause the aircraft

to bank and turn. The rate at which the aircraft rolls is governed by the amount of pressure applied. Hold the pressures constant until you obtain the desired angle of bank. In establishing this bank attitude, use both outside and instrument references.

2.7.2. As bank is introduced, a point on the windscreen directly in front of you will appear to pivot on the horizon. This imaginary level flight reference point should remain on or near the horizon throughout the turn to maintain level flight (figure 2.3). As the bank increases, the pitch attitude will have to increase to compensate for the loss of vertical lift. In shallow turns, the increase in pitch attitude is relatively slight. As bank increases, the required increase in pitch attitude is more pronounced. Also, in steep turns increased power is required to maintain airspeed.

2.7.3. Just as in straight-and-level flight, outside references can be found in any direction. The best outside reference for the degree of bank is the angle of the Earth's horizon across the windscreen. As you approach the desired angle of bank, return the ailerons and rudder to neutral. This stops the bank from increasing. The elevator pressure is not released, but is held constant to maintain a constant pitch attitude. Throughout the turn, the angle of bank should be held constant with adjustments of the ailerons, just as the wings are kept level in straight-and-level flight.

2.7.4. To correct a nose-low attitude in a steep turn, reduce the angle of bank with coordinated aileron and rudder pressure. Simultaneously use back pressure to raise the nose to the desired pitch attitude. After doing this, reestablish the desired angle of bank. Do not try to make corrections with any one of the three controls; use them together.

2.7.5. The rollout from a turn is much the same as the entry except control pressures are used in the opposite direction. Apply aileron and rudder pressure in the direction of the rollout (toward the high wing). As the angle of bank decreases, release the elevator pressure smoothly to maintain altitude. With decreasing angle of bank, the effects of centrifugal force and the loss of vertical lift are reduced.

2.7.6. Since the aircraft normally will turn as long as there is any bank, start the rollout before reaching your desired heading. The aircraft will turn some during the time it takes to level the wings. The steeper the bank, the more lead required to roll out on a desired heading. Release the pressures smoothly until the controls are neutral-

ized as the wings become level. Your posture in the aircraft is very important to all maneuvers. Do not lean forward, backward, or side to side. Instead, sit erect and move your head around freely (figure 2.4). During turns, maintain this position. Do not lean away from the turn or attempt to keep your body vertical with the horizon. Relax and ride with the turn. If you do not maintain a constant position in the cockpit, your outside references will continually change. Relaxed pilots are usually good pilots because they are free to think and can feel the pressures on the controls.

2.7.7. Plan all of your turn exercises so you make precise turns; that is, with a constant angle of bank and a definite amount of turn. To make a precision 90° turn, align the aircraft with a road or section line on the ground and turn perpendicular to it. In the absence of any ground reference, pick a point on the horizon that is directly off a wingtip; then turn to that point. Clear the area as you do this.

2.7.8. A common misconception among students is that a steep turn is entirely different from a shallow turn. This mistaken idea probably comes from the fact that all of the aerodynamics of a turn are more prominent in a steep turn. Basically, the difference between steep turns and other turns is the amount of back-stick pressure and power needed to maintain level flight. A common error is the misuse of controls when entering a steep turn. Some students apply control pressures very rapidly and abruptly, using strong back pressure prematurely. This is sometimes caused by the natural tendency of the arm to move backwards as it moves to the side. Steep turns are easy to perform if you roll into them like you roll into shallow turns, but you should anticipate the need for additional back pressure and power as the angle of bank increases.

2.8. Area Orientation. You are required to carry a copy of your local in-flight guide and a map of the local flying area on all flights. Use your map and landmarks as primary references for departure, recovery, and area orientation. Additionally, use the aircraft's navigation equipment as a backup in case of restricted visibility or unfamiliar area assignment.

2.9. Uncoordinated Flight. In a coordinated level turn with constant bank and airspeed, the flight path of the aircraft is a true circle if the wind is calm. Otherwise, the flight path is not necessarily a true circle over the ground because of drift. Variation in the circular flight path is also caused by uncoordinated control, erratic bank, or changes in airspeed.

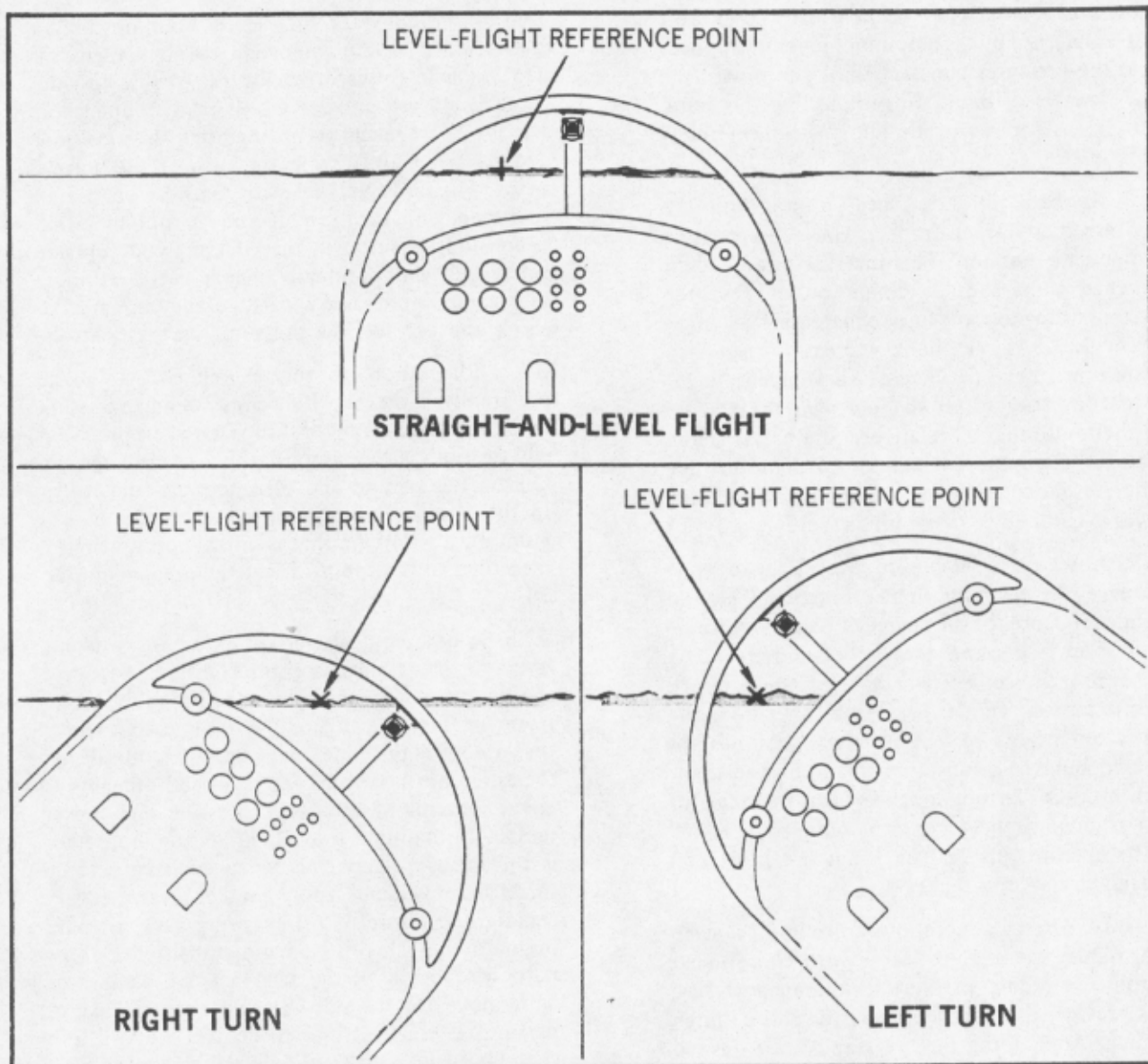


Figure 2.3. Cockpit View of Level-Flight Reference Point.

2.9.1. Skid. A skid is caused by insufficient bank angle in relation to the turn rate of the aircraft (figure 2.5). This will occur if you use too much bottom rudder pressure in relation to the aileron pressure or if any bottom rudder is held after a turn is established. A skid will also occur in level flight if the nose of the aircraft rotates sideways about the vertical axis when the wings are held level, resulting in a slow turn. This occurs when rudder pressure is inadvertently held or the aircraft is improperly trimmed.

2.9.2. Slip. A slip is caused by too much bank angle in relation to the turn rate of the aircraft (figure 2.5). When establishing a turn, if you use insufficient bottom rudder pressure in relation to



Figure 2.4. Posture in a Turn.

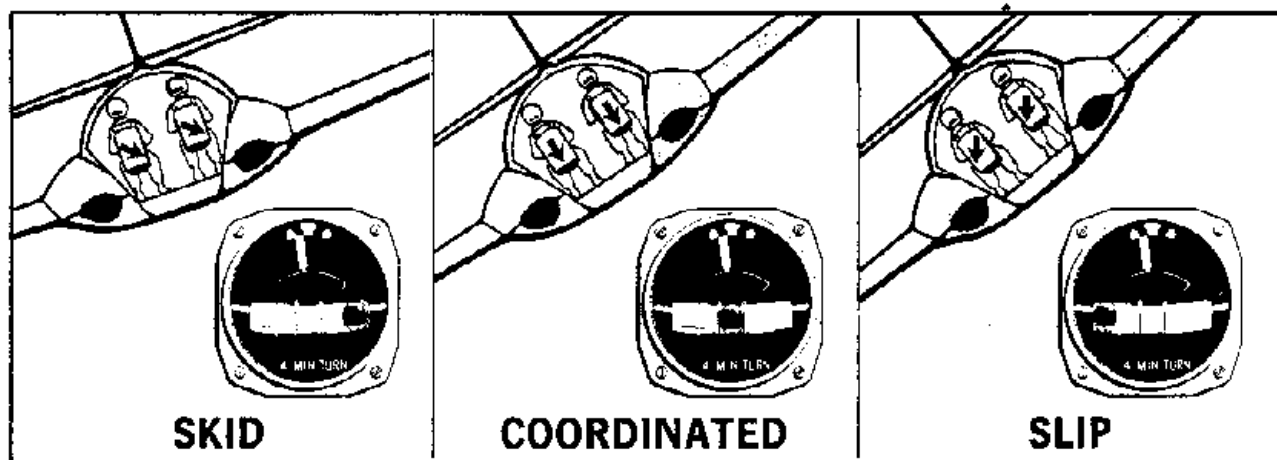


Figure 2.5. Direction of Force on a Body in Coordinated and Uncoordinated Turns.

the aileron pressure, a slip will result. You can also slip the aircraft by holding opposite rudder in a turn.

2.10. Basic Instrument Flight. Instrument flying is controlling the aircraft by reference to the flight instruments only. Use the same control techniques you use in contact flying. Instrument flying is similar to contact flying in that reference points are used in both to determine the attitude of the aircraft. However, in instrument flight, aircraft instruments, instead of outside references, will show you the attitude of your aircraft in relation to the horizon.

2.10.1. Instrument flying is a series of basic maneuvers. The particular situation determines the sequence in which these maneuvers are performed. For example, both a radar approach and low-altitude approach contain many of the same maneuvers, but the sequence for making the turns, descents, level offs, etc., is not the same. It is easy to understand instrument flying if you consider it a series of basic instrument maneuvers. Confidence and the vertical-S maneuvers are practiced to improve your ability to interpret the instrument and increase your proficiency in instrument flying.

2.10.2. You must use all of the flight instruments to precisely determine aircraft attitude. Correct interpretation of their indications and good pitch, bank, and power control are the basic elements of attitude instrument flying. Flight instruments are divided into three main groups according to their functions. This grouping presents the information for the best possible coverage. The three groups are control instruments (attitude indicators and power instruments), performance instruments (altimeter, VVI, airspeed indicator,

turn-and-slip indicator, and heading indicator), and navigational instruments (VOR, DME, and ILS equipment). During the early phase of instrument training, the navigation instruments are not used. They are used later to determine aircraft location.

2.10.3. There are two points that cannot be overemphasized when flying on instruments: (1) initiate corrective action to maintain the desired aircraft attitude the moment you confirm a need, and (2) make all corrections smooth but positive. The performance instruments indicate the need for a change in aircraft attitude. Make these changes by using the attitude indicator and throttles as necessary. Cross-check the performance instruments to determine the adequacy of the correction and make any refinements necessary to attain the desired attitude. The nature of the maneuver flown will determine which performance instruments will receive most of your attention, but constantly cross-check all of them for precision instrument flying. To understand instrument flying, carefully study the techniques and procedures found in AFM 51-37, FLIP General Planning, TO 1-T-37B, this chapter, and chapter 9.

2.11. Pitch Control. An understanding of the similarity between contact and instrument flying is necessary when you cannot determine the attitude of the aircraft by use of outside references. The aircraft can be precisely controlled using the instruments. The attitude indicator, altimeter, VVI, and airspeed indicator give indications of the pitch attitude of the aircraft. Small, timely pitch corrections on the attitude indicator and an accurate cross-check of the performance instruments are essential to developing good pitch control technique. Proper use of elevator trim is

an integral part of pitch control; good instrument flying is very difficult without it.

2.11.1. Attitude Indicator. Without the hood, fly the aircraft straight and level. Adjust the attitude indicator so the wings of the miniature aircraft (shown on the attitude indicator) are superimposed on the horizon bar. While changing pitch, note how the relationship on the instrument corresponds to the actual movement of the nose of the aircraft as it appears on the natural horizon. Cage the attitude indicators only when errors have been induced in the instrument and positive relation to level flight can be confirmed. (The flight manual for the T-37 aircraft has information on the construction and limitations of the attitude indicators.) During in-flight practice, change the pitch attitude so the miniature aircraft indicates a climb of 2° . Compare this movement to the movement of the nose of the aircraft as it appears on the natural horizon. Then reverse this maneuver to show a descent. You can maintain level flight by keeping the wings of the miniature aircraft centered exactly on the horizon bar. Changes in pitch attitude are normally very small, not more than 1° . Your instructor will occasionally place the aircraft in a steep climb or dive and have you return it to level flight. This is to give you practice for special maneuvers that will come later.

2.11.2. Altimeter. Fly the aircraft straight and level with a fixed power setting. To maintain a constant altitude and airspeed, the pitch attitude must remain constant. Raise the nose of the aircraft until the miniature aircraft is well above the horizon bar. Observe that the altimeter changes rapidly with any substantial change in pitch attitude on the attitude indicator. Make a small change in pitch attitude. Observe the correspondingly slow change in altitude indicated on the altimeter. Make an abrupt change in the pitch attitude. Observe the momentary lag in the altimeter. Note that a lag is not as apparent when a gradual change is made in the pitch attitude. Even though there is a momentary lag in the indication of the altimeter, if the pitch change is smooth and gradual, the altimeter gives an almost immediate indication of a change in pitch attitude.

2.11.2.1. To control the pitch attitude of the aircraft properly throughout a flight, you must use both the attitude indicator and the altimeter. Consequently, a system of cross-checking must be developed. You should not rely solely on the attitude indicator because a change in airspeed will require an attitude change to maintain level flight. With only two instruments at this stage of instruction, the cross-check consists of merely

looking from one instrument to the other. During level flight the attitude indicator should receive more attention than the altimeter, but cross-check the altimeter to make sure you are keeping the altitude constant.

2.11.2.2. Practice holding the altitude constant using the attitude indicator and the altimeter. Correct for a deviation of 100 feet by changing the pitch attitude not more than 1° . Corrections in altitude are made by these small changes in pitch attitude.

2.11.3. Vertical Velocity Indicator (VVI). While the VVI gives an immediate indication of a change in pitch attitude, there is a short lag before it settles down and indicates the actual rate. This lag is directly proportional to the speed and magnitude of the pitch change. The VVI is a trend instrument so do not chase it. Make small corrections and then wait for the instrument to settle down. Use the VVI as a trend instrument to prevent overcontrolling. Practice maintaining level flight by cross-checking the attitude indicator, VVI, and altimeter. Place emphasis on precision. To learn the function of the VVI and its relationship to other pitch instruments perform the following exercises:

2.11.3.1. From level flight, place the aircraft in a dive by making a large change in pitch attitude. While the vertical velocity is rapidly decreasing in the descent, pull the aircraft up into a climb. Observe that after the lag, the vertical velocity reverses its direction of movement and begins to move rapidly upwards, indicating a change in pitch attitude.

2.11.3.2. During practice, raise the nose of the aircraft so the attitude indicator indicates a climb of 1° . A change in pitch of this magnitude indicates a vertical velocity of 300 to 400 feet per minute (fpm). This relationship between the attitude indicator and the VVI is for low speed flight. In higher performance aircraft at higher speeds, a 1° pitch change might indicate a climb of as much as 1,000 fpm.

2.11.3.3. For altitude corrections, one technique is to change attitude to get a vertical velocity in fpm that is about double the error in feet of altitude. For example, if you are 100 feet off your altitude, a 200 fpm correction is generally suitable.

2.11.3.4. In level flight, cross-check the three pitch instruments to detect a deviation in altitude. Add VVI to the sequence of the pitch attitude cross-check previously described. Any deviation of the vertical velocity needle from zero shows the need for a change in pitch attitude.

2.11.3.5. Next establish a climb or descent of about 100 fpm. Note the VVI shows the change in pitch attitude earlier than the altimeter, and the VVI's movement is easier to detect than the attitude indicator.

2.11.3.6. Now descend to 100 feet below the desired altitude and establish a climb to return to the original altitude. To do this, change the pitch a small amount on the attitude indicator and cross-check the VVI to maintain a climb of approximately 200 fpm. Cross-check the altimeter to determine when to start the level off. (Normally 10 percent of VVI will be adequate.)

2.11.4. Airspeed Indicator. Airspeed remains constant when in straight-and-level flight with a constant power setting. Small changes in pitch attitude produce very slow changes in airspeed. Extreme changes in the pitch attitude produce faster changes in airspeed. From cruising airspeed in straight-and-level flight, climb or dive the aircraft. The apparent lag in the airspeed indication is caused by the time required for the aircraft to accelerate or decelerate after the pitch attitude changes. However, there is no appreciable lag in the correct indication of this instrument. Bring the airspeed indicator into the cross-check in the same way as the attitude indicator, altimeter, and VVI. As more instruments are added, a quicker cross-check is needed.

2.11.5. Elevator Trim. Your instructor will have you fly the aircraft in level flight with the elevators out of trim. Note that stick pressure is necessary to hold the desired pitch attitude. Adjust the elevator trim to relieve the pressure, and note how the aircraft flies hands off. In straight-and-level flight, change the power setting to note how it becomes necessary to hold pressure on the stick to hold your altitude as airspeed changes. Relieve this pressure with elevator trim. The importance of keeping the aircraft trimmed cannot be overemphasized. From level flight, you will make various power changes and practice the use of elevator trim.

2.11.6. Summary. An efficient cross-check is essential for precise instrument flying. The earlier a deviation is noted, the smaller the correction necessary to counteract the deviation. The attitude indicator is the most informative instrument for pitch attitude control in level flight, but you should cross-check the altimeter and VVI with the attitude indicator to ensure the altitude remains constant.

2.12. Bank Control. An accurate and timely cross-check between control and performance instruments is necessary. The attitude indicator gives

direct information about the bank attitude of the aircraft. The heading indicator and turn indicator provide turning information. Proper use of rudder and aileron trim is essential to good bank control. When you are in straight-and-level flight, maintain your attitude by using the attitude indicator. The performance instruments are used to help you maintain a constant heading and altitude. The cross-check should always be as rapid and accurate as possible, even in simple maneuvers. This allows more time to direct your attention to other matters in the advanced phases.

2.12.1. Attitude Indicator. The horizon bar, through gyroscopic properties, stays parallel to the actual horizon. The aircraft's actual attitude is duplicated on the attitude indicator by the miniature aircraft. This is easier to visualize if you imagine yourself in the miniature aircraft. Proper control of the miniature aircraft is also proper control of the actual aircraft. Two indications on the ARU-44A attitude indicator are used to determine if the aircraft is inverted. If the bank pointer is in the bottom half of the instrument case, the aircraft is inverted. If the words CLIMB or DIVE or the numbers showing degrees of climb or dive (30° to 60°) appear upside down, the aircraft is inverted. Precession errors in the attitude indicators will frequently occur when executing steep turns. The maximum precession error usually occurs after 180° of turn. When the aircraft returns to straight-and-level flight, the miniature aircraft may still show a slight bank because of the precession of the attitude indicator in the turn. During a steep turn, the precession will be more apparent than in a normal turn.

2.12.2. Heading Indicator. The heading indicator gives an indirect indication of bank. As you roll the aircraft into a very shallow bank, note that the heading pointer moves slowly in the direction of bank. When you increase the bank, note the corresponding increase in the rate of turn on the heading pointer. For turns of 30° or less, the bank angle should approximate the number of degrees to be turned. For turns of more than 30° , use a bank angle of 30° . This is a good rule to prevent overcontrolling the aircraft. After becoming proficient, add the heading indicator to the cross-check with the other instruments used to maintain straight-and-level flight.

2.12.3. Turn-and-Slip Indicator. This instrument is composed of two major elements, the turn needle and the ball. The importance of the turn-and-slip indicator has been deemphasized in recent years because of improved reliability of attitude indicators and improved instrument flight proce-

dures. It is still used when trimming the aircraft and for emergency bank indications if the attitude indicator fails. If such a failure occurs, the turn-and-slip indicator is the only instrument available to help keep the aircraft upright. It is less likely to fail than the attitude indicator because it is less complicated and runs on direct current (DC), whereas the attitude indicator (except ARU 42A) needs alternating current (AC) and will fail if the inverters fail.

2.12.3.1. When the turn needle is exactly centered, the aircraft is in wings-level flight. When the aircraft is banked, the turn needle will deflect from center indicating the direction of turn. Your instructor will have you occasionally cross-check the turn needle to support the other instrument indications.

2.12.3.2. The ball is used to determine whether the aileron and rudder trim are set correctly. The aircraft is improperly trimmed when the wings are level and the ball is not centered. Hold the wings level with the aileron pressure, and center the ball with the rudder. Relieve all pressures by adjusting the appropriate trim. It is very important to keep the aircraft trimmed properly at all times.

2.12.3.3. Instrument flying is not difficult if the aircraft is trimmed and the instruments are cross-checked properly. An accurate and timely cross-check between control and performance instruments is necessary for good instrument flying.

2.13. Power Control. Correct power settings and standard procedures for changing airspeeds are essential to proper power control. Your instructor will provide techniques that will enable you to quickly set the approximate power setting for the desired performance. The cross-check method used for control and performance is also applicable to power control. Increase the speed of your cross-check when power changes are made. Power changes that result in airspeed changes affect the attitude of the aircraft. These changes require elevator control pressure to prevent any undesired change in the pitch attitude. This pressure is then relieved by elevator trim.

2.13.1. Power Corrections. When you increase power, the aircraft has a tendency to climb as the airspeed increases. Forward pressure on the elevator control is necessary to maintain a constant altitude. Use elevator trim as necessary. With a decrease in power, the nose has a tendency to drop as the airspeed decreases. Use back pressure followed by elevator trim to maintain a constant altitude. There is a specific power setting that will hold airspeed at the altitude you choose. If you want 200 knots at 10,000 feet, level off at 10,000 feet, accelerate, and set the power on the tachometer at the rpm you think should hold 200 knots. Keep the aircraft at 10,000 feet with elevator control, and watch the airspeed indicator. If the airspeed stabilizes at more than 200 knots, you must reduce rpm. If it stabilizes at less than 200 knots, you must increase rpm. Again allow the airspeed to stabilize to determine whether a further power correction is needed. Altitude is maintained with pitch control, and airspeed is maintained with power control. A quick cross-check between the airspeed indicator and the altimeter will indicate the need for a power or pitch change.

2.13.2. Combined Corrections. When the altitude is correct and the airspeed is not, a power change is needed to regain the desired airspeed. When both the altitude and the airspeed are incorrect, use the elevator control to correct the altitude and power to adjust the airspeed. If you are below the desired altitude with a high airspeed, you might be able to deplete the excess airspeed with a pitch correction that will return you to the desired altitude. Similarly, if you are above the desired altitude with a low airspeed, you may be able to regain your desired airspeed with the required pitch correction to bring you back down to altitude. This is the reason you generally correct first for pitch and then for power, as required. Obviously, if you are high and fast or low and slow, you will need simultaneous corrections of both pitch and power. You will be required to combine the cross-check of the control and performance instruments with precise power control to maintain straight-and-level flight. During power corrections, the speed of the cross-check must be increased so control corrections can be timely and small.

Chapter 3

EMERGENCY PROCEDURES

NOTE: The emergency procedures in this section supplement those in the T-37 flight manual. The importance of studying all emergency procedures cannot be overemphasized.

3.1. Bail Out. If it is necessary to abandon the aircraft, the aircraft commander will use the term **BAIL OUT** as the final command. If time and conditions permit, the crewmembers should discuss ejection procedures before ejecting. In critical situations, do not delay ejection waiting for the command to bail out and do not delay ejection once the aircraft commander has given the command.

3.2. Complete Electrical Failure, Day or Night. If you encounter complete electrical failure, fly over the runway supervisory unit (RSU) or tower, as applicable, at an altitude of 500 feet above the ground (AGL) and at an airspeed of 200 knots. This will alert the controller to your situation.

3.2.1. At the end of the runway, make a 180° climbing turn to the downwind leg. Roll out at normal pattern altitude. Use landing gear emergency extension procedures to ensure the gear is down and locked. Full flaps are optional. With complete electrical failure, the speed brake, spoilers, trim, thrust attenuators, flap indicator, and nose wheel steering are inoperative.

***3.2.2.** Be alert for a red light or flare from the RSU or tower. This may be a warning of some unseen hazard. If you receive a steady green light or no light from the RSU or tower and it appears a safe landing is possible, continue with the approach and landing.

3.2.3. Without the speed brake and thrust attenuators, the importance of establishing a proper final approach cannot be overemphasized. If a go-around is required, start it as early as possible and do not attempt to raise the gear. With complete electrical failure at night, you can see other aircraft but they cannot see you, so be especially alert.

3.2.4. In certain situations, you may fly the electrical failure pattern when you do not have radio contact with the RSU or tower and want to declare an emergency. Depending on your problem, you may continue with an overhead pattern or perform a straight-in approach.

***3.3. Radio Failure, Day or Night.** When the

RSU is in control of the runway, fly a normal overhead pattern, rocking the wings on initial. Watch for a green light from the RSU. If no light is received, flash the taxi light on final and continue the pattern. Do not sacrifice aircraft control to flash the light. When the RSU is not in control of the runway, fly the aircraft alongside the landing runway while rocking the wings. Turn to downwind at the end of the runway and check the tower or RSU for a green light on base leg and final approach.

3.4. Physiological Problems. There are many physiological factors that may affect a pilot. They have one common result—degraded pilot performance. The cause may be hypoxia, hyperventilation, bends, chokes, or cramps. Symptoms are not the same for every pilot. In physiological training you were allowed to experience and identify some of your symptoms. Learn to recognize your symptoms or the degraded performance. If noted, gang load your oxygen controls, declare an emergency, and descend below 10,000 feet mean sea level (MSL). When able, refer to the aircrew checklist for oxygen system emergency operation. Land as soon as practical, even if you begin to feel better. The flight surgeon will meet the aircraft and check your personal equipment.

***3.5. Visual Flight Rules (VFR) or Low-Level Emergencies.** Almost any VFR or low-level en route emergency will demand that you climb the aircraft to a safe height above the terrain so you may analyze the situation safely and establish radio contact. If you have maintained positional awareness and are able, proceed to the nearest suitable airfield while handling the problem. If unable to contact a controlling agency, follow the local lost-communication procedures, specific route lost-communication procedures listed in **FLIP AP/1B**, or the general lost-communication procedures in the **FLIP** flight information handbook. Some emergencies you should reference in the preflight briefing are engine failure at low altitude, bird strike, canopy failure, low-level divers, and weather.

3.5.1. Compute a route abort altitude for each VFR or low-level navigation route flown, and clearly annotate the altitude on the chart for easy reference in flight. Compute this altitude to provide 1,000 feet (2,000 feet in mountainous terrain) clearance from the highest obstacle within 10

nautical miles (NM) either side of course for the entire route.

★3.5.2. Instrument meteorological conditions (IMC) encountered while flying VFR or low-level navigation constitute an emergency situation. If you cannot avoid flying into IMC, immediately abort the route and climb to your emergency route abort altitude or higher if appropriate. The climb should be expeditious, using military power and a safe airspeed. Several factors, such as the terrain or the nature of the emergency, will influence the airspeed used to abort the route. Normally, a minimum of 160 knots indicated airspeed (KIAS) is sufficient during the climb. To abort, immediately establish a climb on course and do not, under any circumstances, attempt to reenter the route once an abort has been initiated. Route aborts are potentially disorienting; immediately transition to instruments and pay close attention to aircraft control and flight parameters. After reaching the route abort altitude, level off, squawk emergency if appropriate, and coordinate with the appropriate controlling agency for an IFR clearance to destination. A climb to an altitude higher than route abort may be necessary to ensure obstruction clearance during the recovery to the destination airfield.

★3.5.3. If at any time you miss consecutive checkpoints or turn points and do not recognize any references from your map, climb to the top of the route structure. Maintain planned headings and airspeed while attempting to identify major references. Use any available VOR to fix your position. Check past actions to trace a possible navigation error. If unable to reorient yourself, abort the route and follow the lost procedures discussed in paragraph 3.8.

★3.6. **Airspeed Indicator Malfunction.** An interruption of static or impact pressure will cause an airspeed indicator malfunction. An obstruction at the static ports or pitot tube will cause erroneous cockpit indications. This may result in a slow decrease toward zero or possibly a stable indication. You should suspect a malfunction if you note any improper response. It is important to ensure the pitot heat is turned on when flying in visible moisture to prevent the formation ice.

3.6.1. The corrective action taken for pitot-static system malfunctions will vary, based on the situation. Because we do not have an alternate static system, an emergency source of static pressure can be obtained by breaking the glass of one of the differential pressure instruments. In this case, the instructor's airspeed indicator or altimeter

would be the best choice, but anticipate slightly higher than actual airspeed indications. The only cockpit correction for pitot tube blockage is to use pitot heat.

3.6.2. Recovery and landing with an airspeed indicator inoperative will vary, based upon the availability of a chase aircraft to lead you down for landing. Since this is the preferred method of recovery, coordination with ground agencies may be necessary to facilitate an airborne rendezvous. Use caution during flight without an airspeed indicator. You must use approximate power settings and pitch attitudes to maintain the desired airspeeds. Avoid rapid pitch and power changes and initiate immediate recovery procedures for any stall indications.

3.6.3. If your situation dictates a single-ship recovery and landing, consider your proficiency level and familiarity with different patterns. This may determine whether you elect to fly an overhead pattern or straight-in approach. In either case, plan your approach carefully and use appropriate power settings to provide safe airspeed control.

3.7. **After Landing With an Emergency.** If you require assistance from fire protection or maintenance personnel during an emergency or precautionary landing, hold the brakes and raise both hands to signal that it is clear to inspect the aircraft. Do not actuate switches without visual coordination with the ground crew.

3.8. **Lost Procedures.** If you do not pay attention to where you are flying, you may become lost or disoriented. You should have a map of the area so keep yourself oriented in relation to known landmarks at all times. If you should become lost, do not hesitate to call for assistance. It is far better to admit you are lost and get help than to wander aimlessly until you are low on fuel and have to bail out.

3.8.1. Fuel consumption is extremely critical. You should take immediate steps to conserve your remaining fuel. While calling for assistance and trying to determine your position, climb to the optimum altitude as indicated in the diversion range summary chart and establish maximum endurance airspeed (125 KIAS).

3.8.2. Attempt to contact an air traffic control radar facility on ultra high frequency (UHF). If there is no contact, channelize the radio to other frequencies listed in your in-flight guide. Squawk mode 3 code 7700 or emergency on your identification, friend or foe/selective identification feature (IFF/SIF). If you can not contact a radar

facility on the listed frequencies, attempt contact on Guard (243.0). Preface your calls with, "Mayday, Mayday, Mayday," and give your call sign and type of emergency. Several controlling agencies will probably answer your distress call. Select one agency, and tell the rest to remain silent. The agency you select will attempt to identify you by requesting that you change your IFF code. Once you are identified, you will be given directional information to the nearest suitable airfield or, if sufficient fuel exists, to your home field.

3.8.3. Remember, the UHF radio works on a line-of-sight transmission principle. The higher your altitude, the more likely you are to obtain a good steer from a ground facility. The following is an approximate range for transmission over flat terrain:

<u>Aircraft Altitude</u>	<u>Range</u>
5,000 feet	55 miles
10,000 feet	140 miles
20,000 feet	200 miles

3.8.4. If you cannot establish radio contact with any controlling agency, try to determine your position by radial and DME from a known navigational facility. If the DME is inoperative, try to orient yourself by using two VOR stations. Tune in a nearby VOR, and note the radial you are on. Draw this line from the VOR on your map. Tune in another nearby VOR, and note the radial you are on. Draw this line from the second VOR on your map. The point where the two radials cross is your position within 2 or 3 miles. Factors such as inaccurate plotting and movement of the aircraft affect the accuracy of the fix. However, in the absence of other landmarks, this two-bearing fix is very useful.

3.8.5. If you decide to accept radar vectors or attempt to home to a station, ensure that your RMI/J-2 heading indicator is operating properly. Check it with the standby magnetic compass. If they do not agree, rely on the magnetic compass. In this case, the RMI would be unreliable because it is connected to the J-2 system; however, you may use the CDI to determine the bearing to the station. To do this, set a course in the course window by centering the CDI with a TO indication on the TO/FROM indicator. Use the CDI to establish a course to the fix while using the magnetic compass for heading information. Once you are oriented, maintain maximum range airspeed as indicated in the diversion range

summary chart.

3.8.6. If you are unable to establish your position or navigate using aircraft instruments, pick out some outstanding landmark on the ground. A significant body of water, a town, or a railroad crossing are all good landmarks. Try to find your selected landmark on your local area map. You should have some idea of your general location so look for your landmark in that general area on your map. Orient your map with the aircraft heading.

3.8.7. If you cannot locate the landmark on your map, don't just wander around aimlessly; fly a definite heading until you can pick up another good landmark. Set up an orbit around it and identify it.

3.8.8. If you still cannot locate your position, look for a suitable airstrip and land before you run out of fuel. If you cannot locate an airstrip before running out of fuel, EJECT. Do not attempt to make a forced landing.

★3.9. **Trim Malfunctions.** A trouble-free trim system is essential to minimize fatigue from out-of-trim stick forces. You should not attempt to fly an aircraft that fails the preflight trim check. Once airborne, a trim system failure could result in heavy stick forces leading to muscular fatigue or even loss of aircraft control due to disorientation from unusual stick pressures. The most effective way to reduce or eliminate stick forces caused by trim failure is to reduce the airflow over the control surfaces and trim tabs. Flying at faster airspeeds dramatically increases the force required to maintain a desired pitch. The design of the T-37 is such that nose down stick forces may increase as airspeed increases at nose down trim settings. These nose down forces may become extreme at high airspeeds, and the only way to bring these forces under control is by reducing airspeed or retrimming. If you experience trim failure or runaway trim at low altitude, consider trading airspeed for altitude and climbing. In addition to trim failure, the trim actuator could "run away" as a result of a malfunction or inadvertent application by a crewmember. This could result in very heavy stick forces. Anytime you experience abnormal stick forces, use pitch and power to achieve an airspeed range of 110-150 KIAS and refer to the "Runaway Trim" section of the checklist.

Chapter 4

TAKEOFF, CLIMB, AND LEVEL OFF

4.1. Pretakeoff. You must prepare yourself and the aircraft for the takeoff. Make absolutely certain all applicable procedures and checklist items have been completed. When cleared for takeoff, before taxiing onto the runway, ensure the canopy is locked and the warning light is out. If more than one aircraft is cleared into the takeoff position, use alternate sides of the runway to avoid exhaust blast. Look around to make sure that you are clear of all other aircraft, and clear final approach. Taxi onto the runway, ensuring the nose wheel is aligned straight down the runway.

4.2. Takeoff Options. Initially, you will practice only static takeoffs. Later, you and instructor will have the option of a rolling takeoff.

4.2.1. Static Takeoff. One method of initiating the takeoff is a static engine runup. Pump up the brakes and exert as much pressure as necessary to prevent creeping during engine runup. Look down the runway, and run up the engines to military power, glancing into the cockpit only momentarily to ensure the EGT has not exceeded limitations. Your primary concern at this time is to ensure the aircraft is not creeping forward or pulling to one side. When the engines have stabilized at military, complete the lineup checklist. Divide your attention between checking each item and holding the aircraft in position. When you are ready to begin the takeoff roll, engage the nose wheel steering and release the brakes. If the brakes will not hold satisfactorily at military power, reduce power and pump up the brakes again. If the brakes do not hold during the second runup, abort the aircraft.

4.2.2. Rolling Takeoff. Another takeoff method, used primarily to aid traffic flow in a busy pattern, is a rolling takeoff. It is actually a smooth combination of taxi, application of power, and the takeoff roll. Rolling takeoffs have a negligible effect on TOLD, and no recalculation is required.

4.3. Takeoff:

4.3.1. Takeoff Roll. Maintain directional control with smooth rudder application. You will feel the elevator gradually become effective as the airspeed builds. At this point in the taxi-flight transition, the aircraft is being flown more than taxied. As this occurs, you need to make progressively smaller rudder corrections. At approximately 65 knots (or computed nose wheel lift-off speed), smoothly

apply back pressure to the stick to establish the takeoff attitude and release the nose wheel steering button. Because a good takeoff depends on takeoff attitude, it is important to know how this attitude is attained. The ideal takeoff requires minimum pitch adjustment after the aircraft becomes airborne. Your instructor will demonstrate the takeoff attitude. Use whatever back pressure is necessary to hold this attitude. Keep the wings level by applying aileron pressure. At the takeoff point, all flight controls are effective in maneuvering the aircraft. At any time during the takeoff, a situation may arise that requires an abort. The decision to abort depends on the nature of the problem, speed, and runway remaining. You must make decisions accurately and quickly. With certain types of malfunctions, you may find it advisable to continue the takeoff and then land as soon as practical. In any event, use flight manual procedures and limitations to assist you in making your decision to abort or continue the takeoff. Your instructor will help you develop the judgment to make accurate, timely decisions. There is no substitute for good judgment.

4.3.2. Leaving The Ground. Maintain the takeoff attitude. On initial takeoff as the airspeed approaches 90 knots, the aircraft will fly off the ground. Changes in fuel weights and flap settings will vary takeoff airspeeds. As the aircraft leaves the ground, maintain the correct flight attitude and direction. If insufficient back pressure is held, the aircraft may settle back to the runway after the initial liftoff. However, be careful not to force the aircraft into the air by applying too much back pressure before adequate flying speed is gained. If this happens, the nose may rise so high that a stall develops. Forcing the aircraft into the air prematurely is an unsafe practice and must be avoided.

4.3.3. After Becoming Airborne. The aircraft will pick up speed rapidly after becoming airborne. When you are safely airborne and you have attained a minimum of 100 KIAS, prepare to raise the landing gear. To prevent premature gear retractions, make this a conscious act, using the flight condition of the aircraft as the cue. Never allow gear retraction to become a habitual action or rely on a single cue, such as airspeed. Before raising the gear handle, the pilot flying the aircraft on all dual sorties will make a "gear clear" call. A verbal response is not required except for presolo

sorties. In presolo the instructor pilot (IP) will clear the student to raise the gear. In cases other than presolo, the "gear clear" call is advisory only. It is intended to make the pilot consciously aware of the act of raising the gear and to emphasize that the other crewmember has a responsibility to ensure gear retraction is done properly.

4.3.3.1. When the gear handle is up and the airspeed is above 110 knots, retract the flaps and adjust the pitch attitude slightly to compensate for the loss of lift. After takeoff, confirm the gear handle is up, warning light in the gear handle is extinguished, flaps are up, and engine instruments are checked. Trim to relieve the pressure on the control stick. If no elevator or trim corrections are made during departure, the increased control effectiveness at higher airspeeds will cause a steeper-than-desired climb out. To counter this, continue to increase forward stick pressure on the elevator to maintain the desired climb angle. Concentrate on maintaining the desired pitch attitude after lift-off, and trim to relieve control pressures.

4.3.3.2. When an aircraft has taken off immediately ahead of you, anticipate the possibility of wake turbulence, especially if the wind is calm or straight down the runway. Although sudden deviations in flight attitudes may occur, do not become alarmed. Use firm control pressures to make a very shallow turn in either direction to fly out of the wake turbulence; then realign the aircraft with the original flightpath. If a crosswind is present, make the turn upwind because the wake turbulence will be blown away from your flightpath.

4.3.3.3. Early recognition of power failure is critical. In this aircraft, loss of thrust is usually detected by referring to the engine instruments (tachometer and EGT), by engine sound, or by a change in aircraft direction. Failure to attain or maintain airspeed may also be a clue. During operations such as takeoffs, where loss of thrust is critical, the need for monitoring engine instruments is even more important. Therefore, you should learn to cross-check engine-performance instruments during takeoffs.

4.4. Crosswind on Takeoff:

4.4.1. **Takeoff Roll (Crosswind).** As you taxi into takeoff position, check the wind sock or other wind indicators or get wind data over the radio so you can anticipate the crosswind.

4.4.1.1. The initial takeoff roll technique for a crosswind is the same as for a normal takeoff except the aileron is held into the wind as the takeoff

roll is started. You will also need to apply opposite rudder to keep the aircraft from weathervaning (that is, streamlining itself into the wind).

4.4.1.2. As the aircraft approaches flying speed, the ailerons become more effective. You must reduce aileron deflection to keep the wings level, but you have to maintain some aileron deflection throughout the takeoff roll. This aileron deflection is necessary because the upwind wing develops more lift, causing it to fly (begin rising) before the downwind wing.

4.4.1.3. If the upwind wing rises and exposes more impact surface, a skipping action may result (figure 4.1). This is a series of very small bounces caused by the aircraft attempting to fly on one wing and then settling back onto the runway. During these bounces, the crosswind will move the aircraft sideways and the bounces will develop into side skipping. This skipping imposes stress on the landing gear which could result in materiel failure. In addition, the tendency of the aircraft to weathervane is increased.

4.4.1.4. Use caution during takeoffs in gusty wind conditions for rapidly changing wind direction and velocity. Timely corrections are needed to maintain directional control.

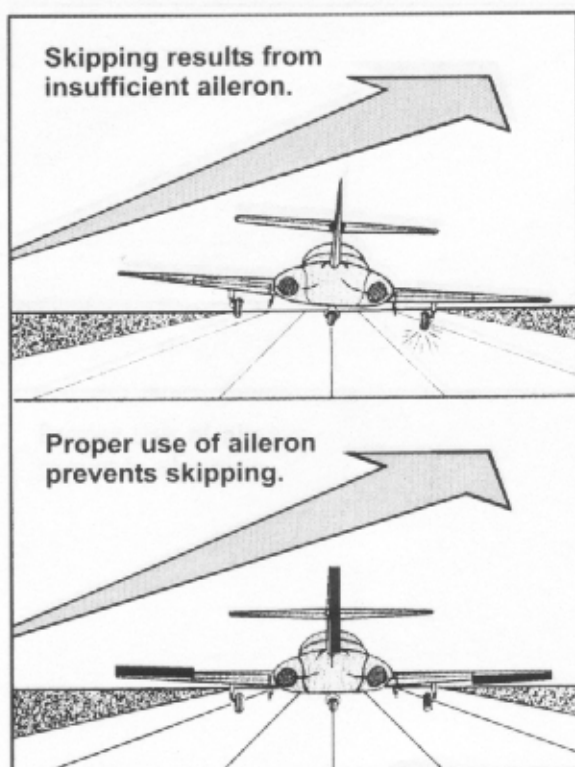


Figure 4.1. Skipping on Takeoff.

4.4.2. Leaving the Ground (Crosswind). As the wheels leave the runway, the aircraft will start drifting with the wind. Relax the rudder pressure, allow the aircraft to turn into the wind until an adequate crab is established, and then neutralize the crosswind aileron. Continue to climb in the crab to maintain runway alignment on the takeoff leg (figure 4.2). The remainder of the takeoff climb is the same as previously explained (paragraph 4.3.3).

4.5. Climb and Level Off:

4.5.1. Turns After Takeoff. After takeoff, climb straight ahead until you are past the departure end of the runway (or as directed). A minimum of 150 KIAS and a safe altitude should be attained before the first turn after takeoff.

4.5.2. Climbs. A normal climb is made at an angle and airspeed that result in the optimum gain in altitude in relation to time (best rate of climb) with power set at military. Below 10,000 feet, climb at 180 knots. Above 10,000 feet, maintain 160 knots. This is called a tech-order climb. You have the option to modify this climb schedule to suit specific mission requirements.

4.5.2.1. If the climb is started from cruising airspeed, gradually decrease the indicated airspeed to obtain the tech-order airspeed for your existing altitude. This change in airspeed is gradual, rather than immediate, because of the momentum of the aircraft and the added power for climb. Continue to climb at tech-order airspeed.

4.5.2.2. Trim is an important consideration during a climb. When you have established the climbing attitude, trim the aircraft to relieve all pressures from the controls. Trim should be a continuous process throughout the climb and level off. When you adjust the flight attitude and (or) airspeed, retrim the aircraft.

4.5.3. Straight-Ahead Climbs. To establish a straight climb from level flight, advance the throttles to military and raise the nose to a climbing attitude. All pitch changes should be made using outside references. Straight flight can be maintained by using section lines or other outside references supported by the heading indicator. A wings-level attitude should be maintained by outside references. An occasional glance at the attitude indicator will help. Your instructor will show you the climbing attitude at different altitudes

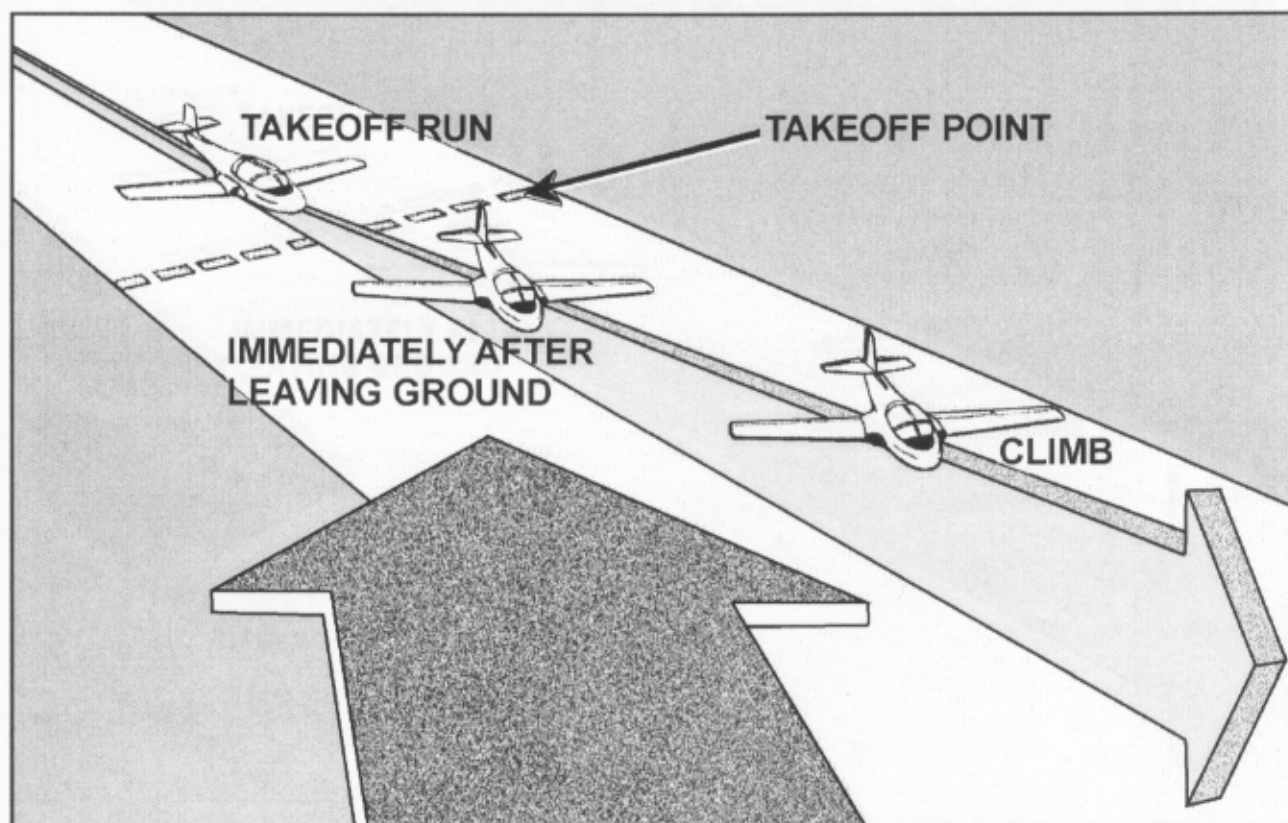


Figure 4.2. Crabbing Into Crosswind After Takeoff.

and the outside references to maintain it. If the wingtips are equal distant from the horizon, a wings-level attitude should be indicated on the attitude indicator. As the climb is established, use back pressure to increase the pitch attitude. When the airspeed decreases to the desired reading, the amount of backstick pressure required to hold the airspeed will become constant. Use elevator trim to neutralize the stick pressure. Once this is done, you will be able to maintain an attitude without holding pressure on the stick.

4.5.4. Climbing Turns. During turns, the loss of vertical lift becomes greater as the angle of bank increases, so use shallow-banked turns to maintain a good rate of climb. During the early part of your training, make each turn a separate maneuver, pausing momentarily before establishing another turn. This will give you practice in entering and recovering from climbing turns. If you trim in the turn, you will experience different pressures during the rollout and you must retrim when the wings

become level. Clear the area continuously during climbing turns.

4.5.5. Level Off From Climbs. Stop your climb at a selected altitude, and establish level flight. Start the level off by using a lead point that will ensure a smooth transition to the desired level-off altitude. One technique is to use a lead point that is approximately 10 percent of the VVI. For example, if you are climbing at a rate of 2,000 feet per minute, start the level off 200 feet below the desired altitude. At the lead point, lower the nose of the aircraft to level flight. Adjust the throttles as necessary to obtain the desired airspeed (cruise power is approximately 90 percent), and retrim the aircraft. Trimming is a continuous process from the time you lower the nose until the airspeed stabilizes. After leveling at cruise and (or) maneuvering altitude, perform the ops check. This check is not required for intermediate level offs. You may combine the ops checks when the level off is at or below 14,000 feet.

Chapter 5

CONTACT

Section A—Stall Training and Slow Flight

5.1. General. Stall maneuvers and slow flight enable you to recognize attitudes, seat pressures, and the control feel that signals unsafe flight conditions. A thorough knowledge of these maneuvers will allow you to fly an airplane safely at maximum performance.

5.1.1. Before performing stalls or slow flight, ensure your loose equipment is stowed and the boost pump is operating. If maneuvers are flown in a series, you are not required to check these items between individual maneuvers.

5.1.2. The stall is best defined as a condition where airflow over the top of the wing becomes separated from the surface of the wing. When this occurs, a turbulent wake develops on and behind the wing and the aircraft suffers a drastic reduction in lift. We are interested in this phenomenon because when the stall occurs, continued flight in the normal sense is no longer possible. If the stall condition is severe, the controls lose their effectiveness and sudden pitching and rolling motions occur. As the stall progresses, control effectiveness is lost in the following order: aileron, elevator, and rudder. During stall recovery, control effectiveness is regained in the reverse order: rudder, elevator, and aileron. Obviously, a stall at low altitude is dangerous because considerable altitude may be lost during recovery. The following material outlines the conditions leading to a stall, stall warning, and stall recovery.

5.2. Conditions Leading to a Stall:

5.2.1. Cause of Stall. Basically, there is one cause for a stall—exceeding the critical angle of attack (AOA). Remember, the AOA is the angle between the chord line and the relative wind. Figure 5.1 shows that a high AOA leads to airflow separation and the formation of a wake of turbulent air behind the wing. Separation begins at a certain AOA. A further increase in AOA will cause separation on most of the top surface of the wing.

5.2.1.1. It is important to realize that an airplane can stall at any airspeed, attitude, or power setting if you demand (with the elevators) an AOA above the critical value. If the airspeed is low, the stall will occur with light seat pressure and low Gs. If the airspeed is high, you will feel considerable Gs and seat pressure when the AOA is sufficient to cause a stall. Figure 5.2 shows the relationship

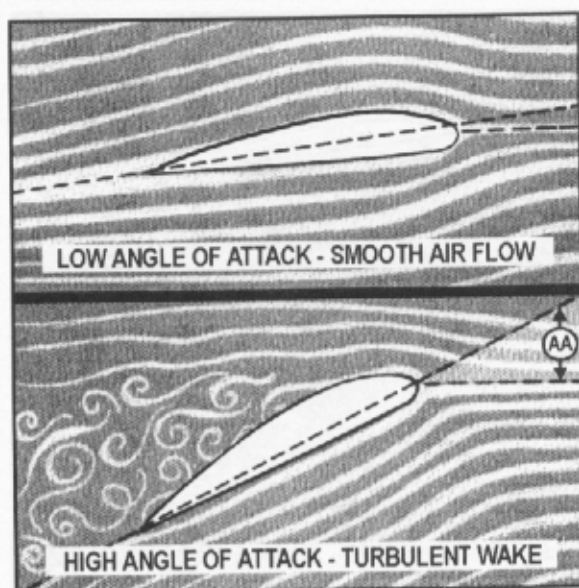


Figure 5.1. Angle of Attack (AOA).

between Gs and stalling indicated airspeed for an average gross weight and clean configuration.

5.2.1.2. Although you need not memorize the stall speeds in figure 5.2, note the direct relationship between Gs (seat pressure) and stalling indicated airspeed. The one-G stall is the level flight stall. Stalls occurring with more than one G are often referred to as high speed stalls or accelerated stalls.

5.2.2. How To Detect an Impending Stall. To become a proficient pilot, you must recognize the flight conditions that cause stalls and know how to apply the necessary corrective action. You must learn to recognize an approaching stall by both sight and feel. You can see abnormal nose-high attitudes and decreasing airspeed which may lead to a stall. During turns and when pulling Gs, you can see the rapid motion of the nose as excessive back pressure is applied. You can feel the control pressures become light and less effective at low airspeeds. During rapid or steep turns, you can feel the excessive pressure forcing you into the seat

Stalling IAS	0	39	56	67	79	112	137	158
Gs	0	¼	½	¾	1	2	3	4
5400 lbs weight, clean configuration								

Figure 5.2. Stall Speed for Varying G Loading.

as well as the excessive pressure you are applying to the controls.

5.2.3. Stall Warning. In a clean configuration, the T-37 provides stall warning in the form of buffet. This is easily understood by referring to figure 5.3, step a. As the stall begins, the smooth airflow starts to separate from the wing in a small region near the wing root. The resulting turbulent wake strikes the tail and shakes the controls. This shaking or buffeting indicates the need to reduce the AOA to prevent a full stall.

5.2.3.1. The full stall is reached at an AOA slightly higher than the angle where buffet begins to be noticed (figure 5.3, step b). The separation has spread over most of the top rear portion of the wing. Tests confirm that as this happens in the T-37, the airflow over the tail surface becomes so disrupted that the elevator can no longer hold up the nose. Thus a sudden decrease in pitch takes place, which is often referred to as nose drop. Nose drop is easily noticed in the low G, high pitch attitude stalls. During level flight stalls and accelerated stalls, nose drop is not so apparent. These stalls are best characterized by very heavy buffet, loss of aileron effectiveness, and rolling motions.

5.2.3.2. When the flaps of the T-37 are lowered, the stalling characteristics of the wing change. Both the stalling AOA and stalling speed are reduced. Also, when the flaps are down, the wing wake does not give a buffet warning of an impending stall. For this reason, the aircraft is equipped with a spoiler system, which provides an artificial buffet warning approximately 4 to 10 knots before stall is reached.

5.3. Stall Recovery. The T-37 has excellent stall-recovery characteristics. The elevator is effective enough to reduce the AOA during the most severe stalls. Aileron control becomes marginal during a full stall, but rudder control is adequate to provide directional control except in the most severe stalls. To recover from a stall or to alleviate approach to stall indications, apply the stall recovery procedures. Do not think of these procedures as steps, one followed by another. Instead, apply them simultaneously because they all aid in the recovery.

5.3.1. Reduce back stick pressure to decrease the AOA. Stick forces required to eliminate a stall will differ with every stall. Therefore, do not push forward on the stick to a predetermined point. At the same time, use the rudder to aid in leveling the wings to reduce the stall speed, and advance the power to military as the speed brake is retracted

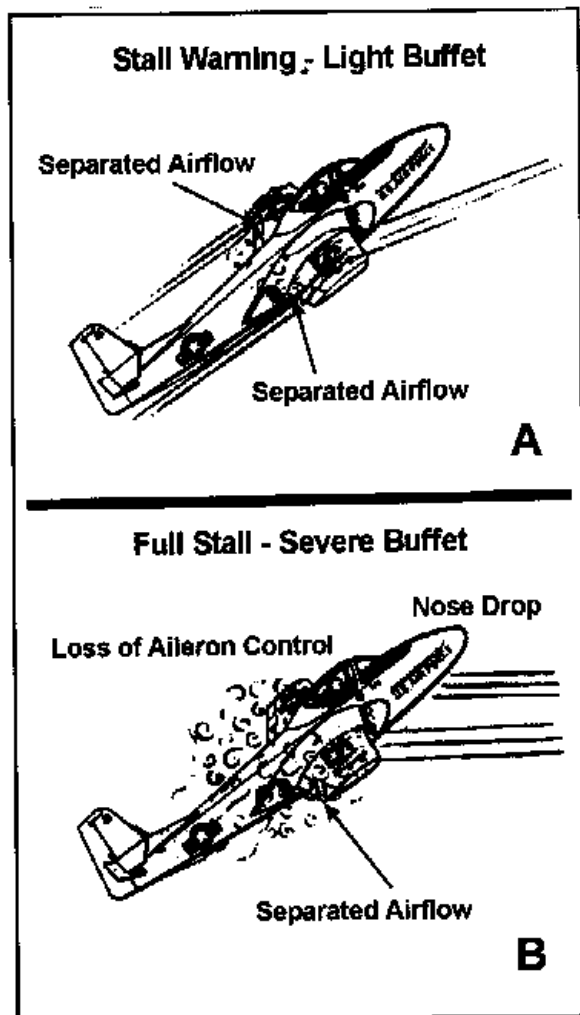


Figure 5.3. Stall Warning.

to increase airspeed. As you feel the aircraft regain flying airspeed, return to level flight.

5.3.2. Reducing the back pressure on the stick to decrease the AOA will restore lift. Thus the aircraft is immediately brought out of a stalled condition and returned to flying condition, although you may still be in a descent. If the wings are severely stalled, the use of aileron is ineffective and will aggravate the stalled condition regardless of the finesse with which the aileron is applied. Use ailerons with coordinated rudder to level the wings after the stall is broken.

5.3.3. Since the throttles are your only direct control over thrust, it is important that you have maximum thrust to expedite the return to level flight by increasing the airspeed. When time is critical, as in low altitude thrust-deficient situations, rapid throttle movement is the most efficient procedure to achieve maximum engine acceleration. Acceleration time is approximately 40 percent less when accelerating from 50 percent rpm to military power versus idle to military power.

5.3.4. The stall recovery is not complete until the aircraft is returned to level flight. Avoid attempting too rapid a recovery, which will result in a secondary stall. Strive to develop a feel for flying the aircraft out of a stalled condition with a minimum loss of altitude.

5.4. Power-On Stalls. Power-on stalls are designed to teach you to recognize and recover from a nose-high attitude, full stall. You will recover from these stalls when control effectiveness is lost. Control effectiveness is lost when the nose drops or an unplanned rolling motion takes place. Full back stick is not needed before initiating recovery, and the exact point where the full stall is reached is not considered a point of emphasis. It is important, however, for you to see how an airplane behaves if recovery from the stall is not made at the first buffet indication. Adjust the throttles to 90 percent rpm prior to the first indication of the stall. Clear the area. Pay particular attention to the area above and in front of your aircraft. It is not necessary to clear before each individual stall maneuver unless you pause too long between maneuvers and fly out of the area you have previously cleared.

5.4.1. Straight-Ahead Stall. To execute a straight-ahead, power-on stall, raise the nose to a pitch attitude between 15° and 50°. Your IP will point out the outside references to use. Slowly and smoothly increase back pressure to hold this attitude until stall occurs. Keep the wings level with aileron pressure.

★5.4.1.1. Recover by using stick forces as necessary to decrease the AOA and smoothly advance the throttles to military. Apply coordinated rudder and aileron pressure to level the wings. Notice how large a pitch change is necessary to recover. Allow the nose to lower until you feel positive pressure on the controls, which indicates the aircraft is regaining flying airspeed. Cross-check the airspeed, and recover with minimum loss of altitude without encountering a secondary stall. The maneuver is complete when you have returned to level flight.

5.4.1.2. At lower pitch attitudes (between 15° and 30°), the aircraft stalls at a relatively high airspeed. Shortly after you lower the nose, the aircraft will regain flying airspeed. At higher pitch attitudes (between 30° and 50°), the stall speed is slower and a greater pitch change is necessary to regain flying airspeed.

5.4.2. Turning Stall. The turning stall is executed in much the same manner. The pitch and power are the same in the turning stall as they were in the straight-ahead stall. The bank is 20° to 30°

in either direction. From straight-and-level flight attitude, set the pitch attitude between 15° and 50° and establish the desired bank. Hold this established attitude with elevator pressure until the stall occurs (usually indicated by nose drop or unplanned roll); then recover straight ahead as you did in the straight-ahead stall. A precision entry is not as important as proper recognition and recovery from full-stalled conditions.

5.5. Traffic Pattern Stall. You will practice traffic pattern stalls to become proficient in recognizing and recovering from stall conditions that could occur in the traffic pattern when you are rapidly cross-checking all available outside and instrument references. The emphasis is on recognizing the approach to stall and the use of recovery procedures, not how the stall series is set up or the flow from one stall to the other. Above approximately 90 KIAS, the spoilers will not extend during configured stalls. Without spoilers, you will have no indication of an approach to stall. Initiate recovery when you recognize an approach-to-stall indication. Buffeting is the best indication of an approach to stall. If a stall indication actually occurs in the traffic pattern, make no attempt to comply with the normal ground track. Recover the aircraft by using the above procedures to safely regain aircraft control.

5.5.1. Break Stall. On a simulated initial, adjust power to maintain 200 knots. Execute the break (clear the area), and reduce power as you would in the traffic pattern. After the turn is well established, steadily increase bank and back pressure until you recognize an approach to stall indication. At this point, execute an immediate recovery by using stick forces as necessary to decrease the AOA. Adjust the angle of bank as necessary, and continue the turn to approximately the 180° point, simulating a downwind leg. When determining the effectiveness of this maneuver, do not consider the altitude lost or gained before the stall.

★5.5.2. **Nose-Low Final-Turn Stall.** On the simulated downwind leg, configure for a normal overhead pattern. Approaching 120 knots, initiate a normal final turn. Ensure the speed brake is out. After the turn is established, lower the nose and steadily increase bank and back pressure until you recognize an approach to stall indication. Recover by simultaneously using stick forces as necessary to decrease the AOA, advancing the power to military, retracting the speed brake, and leveling the wings. Return to level flight as soon as possible. Do not lose any more altitude than necessary.

5.5.3. Nose-High Final-Turn Stall. In level flight at 120 knots minimum, reduce the power as you would on a downwind leg and reconfigure for a normal pattern. Begin a normal final turn. After establishing the turn, raise the nose slightly and shallow out the bank. Continue to turn until you recognize an approach to stall indication. Recovery is the same as for the nose-low final turn stall except airspeed is lower and it will take you longer to return the aircraft to level flight.

5.5.4. Landing Attitude Stall. Extend the speed brake, establish a 100-knot simulated final approach, reduce the power to idle, and execute a normal roundout for landing. Hold the landing attitude constant until you recognize an approach to stall indication. At that point, execute a normal stall recovery.

NOTE: After completing the first instructional unit requiring traffic pattern stalls, the break stall is optional. You may start from a simulated downwind position; however, you are still required to clear the area. The sequence of the turning stalls is unimportant. Your IP has the option of having you fly only one of the turning stalls during the series. Additionally, he or she may demonstrate the approach to stall characteristics in various configurations used in the traffic pattern.

5.5.5. No-Flap Stall. No-flap traffic pattern stalls will also be practiced. In performing the stalls without flaps, use the same configuration, airspeeds, and power settings as in the no-flap landing pattern. While performing these stalls, be aware of the differences in aircraft buffet, pitch attitudes, and stalling airspeeds. Be careful not to exceed the gear-down limiting airspeed during stall recoveries.

5.6. Secondary Stall. A secondary stall is a form of an accelerated stall and is caused by excessive elevator control. It is called a secondary stall because it occurs after a partial recovery from a preceding stall. A secondary stall is caused by attempting to hasten a stall recovery when the aircraft has not regained sufficient flying speed. This stall demonstration is designed to show you what will happen if you rush the return to level flight after a stall or spin recovery. It also teaches you the value of smooth back pressure at critical airspeed and the importance of allowing an aircraft to begin flying before completing a stall recovery. The secondary stall is usually demonstrated after a partial recovery from a power-on stall. Clear the area and perform a normal power-on stall. When the stall occurs, initiate a recovery. Then steadily bring the stick back as if you were trying to rush the return to level flight. Continue to

increase back pressure until the aircraft buffets and the nose stops tracking. Note that the throttles are full forward when the secondary stall is actually entered. When this occurs, use stick forces as for a normal stall recovery.

5.7. Slow Flight:

5.7.1. Slow-Flight Practice. Slow flight will acquaint you with the characteristics of the aircraft at minimum flying speeds and will demonstrate the importance of smooth control application. You will practice slow flight to develop your feel for the aircraft and your ability to use the controls correctly. This will improve your proficiency in performing low airspeed maneuvers. You may enter slow flight after the traffic pattern stalls or by reducing the airspeed and configuring for the maneuver. When the airspeed is below 150 knots, lower the landing gear and make all gear-down checks. Lower the flaps when the airspeed is below 135 knots. (The speed brake is optional.) Continue to maintain altitude while the airspeed decreases. When the airspeed has decreased to 75 to 80 knots, adjust the power to maintain airspeed and altitude. Trim the aircraft as needed throughout these changing flight conditions. You may practice slow flight using the no-flap configuration and 90 to 95 knots.

★**5.7.2. Slow-Flight Demonstration.** Your IP will demonstrate the following handling characteristics of the T-37 at minimum flying speeds and will have you fly some of these to build your proficiency in the aircraft. These demonstrations will help you recognize attitudes and characteristics leading to unsafe flight conditions. During slow-flight demonstrations, recover at the first indication of the approach to stall by alleviating the condition that caused the stall (decreasing the AOA, lowering the flaps, or decreasing the bank). However, this is not the primary method of stall recovery and is used only to enhance the effectiveness of the slow-flight demonstration. If a stall or approach-to-stall indication occurs at any other time or if the stall condition is not immediately alleviated, initiate a normal stall recovery. Excessively rough control movement at minimum airspeed, or a delay in initiating recovery action after a stall or an approach-to-stall indication is recognized, may result in an inadvertent spin.

5.7.2.1. Straight and level. To maintain straight-and-level flight, pitch attitude must increase to maintain altitude and power must increase to maintain airspeed.

5.7.2.2. Control effectiveness. The aircraft will react more slowly to control inputs. Also, it will

take more displacement of the control surfaces to achieve the desired aircraft response.

5.7.2.3. Adverse yaw. Additional displacement of ailerons is required at slow airspeed to achieve the same aircraft response as normal cruise airspeeds. This creates more drag and a noticeable yaw away from your direction of turn. Use coordinated rudder to correct adverse yaw.

★5.7.2.4. Turns. The aircraft rate of turn is determined by the angle of bank and the airspeed. The slower an aircraft is moving through the air, the greater the rate of turn for any given angle of bank.

5.7.2.5. Steep turns. At minimum flying speed, the increased wing loading in a steep turn will cause a stall. This is clearly demonstrated by smoothly increasing bank while attempting to maintain altitude. Recover at the first indication of an approach to stall.

5.7.2.6. Increasing pitch attitude. This demonstration illustrates again the small margin between slow flight and stall. Any attempt to increase the pitch attitude will quickly result in a stall with or without effective stall warning, depending upon the abruptness and magnitude of the pitch change. From straight-and-level slow flight, raise the nose slightly without increasing power. Notice how quickly the airspeed dissipates and stall warning begins. Lower the nose and regain slow flight airspeed at the first indication of the approach to stall.

5.7.2.7. Raising the flaps. First raise the flaps to 50 percent and maintain altitude. The aircraft will accelerate as a result of the reduced drag. Reestablish slow flight airspeed by returning the flaps full down and adjusting power, if necessary. Next, fully retract the flaps. To maintain altitude, the pitch attitude must be increased. As a result of the lower lifting capability (coefficient of lift) and low airspeed, the aircraft will stall. Recover at the first indication of the approach to stall by lowering the flaps or by a stall recovery.

5.7.2.8. Coordination exercise. Coordinated flight during slow flight requires proper application of aileron, elevator, rudder, and power. While practicing slow flight coordination exercises, use approximately 15° banked turns, turning approximately 20° to each side of a central reference point.

Section B—Recoveries From Abnormal Flight

5.8. Recovery Procedures. Throughout your flying career, but particularly during pilot training, you will find that occasionally maneuvers will not go as planned because of improper flight procedures

and (or) disorientation. You may arrive at a flight attitude and airspeed where you could lose aircraft control unless you initiate proper recovery procedures. This is especially true when flying aerobatic maneuvers. The key to recovery is early recognition of an improperly flown maneuver. When you recognize a deteriorating situation, apply the appropriate recovery procedures. Do not delay the recovery in an attempt to salvage a poorly flown maneuver.

5.8.1. Before practicing these recoveries, ensure your loose equipment is stowed and the boost pump is operating. If flown in a series, you do not have to check these items between individual recoveries.

5.8.2. As your proficiency increases, your IP will continue to challenge and develop your ability to recognize recovery situations. When you reach the aerobatic phase, your IP will intentionally fly some poorly performed maneuvers requiring application of these procedures.

5.9. Recovery From Inverted Flight. The correct procedure to recover from inverted flight is to roll to the level-flight attitude. The technique is the same as in any roll maneuver. Roll in the shortest direction to an upright attitude. When possible, maintain a fairly constant pitch attitude during the recovery. If you have low airspeed, let the nose of the aircraft lower while performing the rollback to the level-flight attitude. This prevents a stall and a potential excessive loss of altitude. Your IP will give you the opportunity to practice this recovery technique. He or she will fly the aircraft into an inverted attitude and then let you make the recovery. This will be practiced at various airspeeds. The correct recovery technique is a coordinated rollback to level flight, not a split-S.

5.10. Nose-Low Recoveries. Many of the maneuvers demonstrated and practiced in flying training will result in intentional or unintentional nose-low attitudes. The following information will provide you with a sound basis for a recovery technique:

★5.10.1. Recover from a nose-low attitude with smooth back pressure as you roll to a wings-level attitude. Do not apply back stick pressure unless the wings are less than 90° to the horizon. Start the recovery before the airspeed approaches the aircraft limitations. Any time you are in a nose-low recovery situation with airspeed rapidly increasing, adjust the throttles to idle, extend the speed brake, and return the aircraft to level flight. Other situations may occur with low airspeed and shallow pitch attitudes. In these instances, you may modify the recovery procedures to return to level flight with flying airspeed.

Recovery should not involve the use of maximum allowable G-forces unless the altitude available for recovery is critical. (Severe damage to the aircraft may result if design G limits are exceeded.) Increased wing loading is identified by the increased seat pressure present whenever back pressure is applied to the stick. Airspeed and G loading may increase during the pullout. Perform a proper anti-G strain (paragraph 5.14.1).

5.10.2. Recover from a nose-low attitude smoothly without excessive airspeed or loss of altitude. All aircraft are red lined at a definite limiting structural airspeed (382 knots/.7 Mach for the T-37). This is normally indicated by a red mark on the face of the airspeed indicator. When practicing a nose-low maneuver, do not exceed maximum allowable airspeed (275 knots). Remember, the airspeed does not stop increasing as you begin raising the nose. It may increase until just before level flight is attained. Should you exceed limiting structural airspeed, abort the mission and make an entry in the AFTO Form 781. This write up will result in an overall inspection of the aircraft's structure.

5.10.3. There is a potential for excessive altitude loss in any high speed dive recovery. If the aircraft has progressed to a very high airspeed dive, it is imperative that idle power and speed brake are used for recovery. Should airspeed increase to a point where the aircraft exhibits longitudinal instability, use idle power, speed brake, and back pressure to prevent additional nose-down movements and excessive airspeed. If the critical Mach is exceeded, you must decrease airspeed before a recovery is made.

5.11. **Nose-High Recoveries.** You will intentionally fly the T-37 through nose-high flight attitudes many times during aerobatic practice. Occasionally, because of improper control, you may find yourself in nose-high attitudes with less than optimum airspeed to continue the maneuver. Unless immediate and proper recovery procedures are initiated, the aircraft may enter an aggravated stall which could result in a spin.

5.11.1. The objective of the nose-high recovery is to fly the aircraft to level flight as soon as possible without stalling. To do this, adjust power to military and initiate a coordinated roll with back pressure to bring the nose of the aircraft down to the nearest horizon. Depending on the initial airspeed and aircraft attitude, a wing-level, inverted attitude may be reached. As the nose approaches the horizon, roll to an upright attitude (figure 5.4). Depending on the airspeed, you may need to delay

the rollout until the nose is definitely below the horizon.

5.11.2. During some nose-high situations, when aircraft airspeed is too low or dissipating rapidly, normal recovery control inputs may not be possible without approaching or encountering a stalled condition. Under these conditions or during disorienting nose-high situations, use an unloaded recovery to return the aircraft to level flight. This is done by simultaneously advancing the throttles to military and neutralizing the flight controls. After the controls are neutralized, expect airspeed to dissipate and the nose to lower as the aircraft seeks to regain flying airspeed. Initially, aircraft control authority will be minimal. However, as airspeed increases during the dive, control inputs will become more effective. Allow the nose to lower until you feel positive pressures on the controls. You may need to lower the nose near vertical during this stage of the recovery. Upon regaining flying airspeed, recover the aircraft to level flight. Keep in mind, an unloaded recovery may result in considerable altitude loss.

5.11.3. Initially, your IP will have you practice both techniques for recovery. As you gain proficiency, he or she will allow you to decide on the best technique for a given situation. At times you may attempt a nose-high recovery and have to transition to the unloaded technique due to insufficient airspeed or an approach to stall indication. However, you should learn to evaluate the existing situation and decide on the appropriate recovery technique.

5.12. **Runaway Trim Demonstration.** This demonstration is designed to make you proficient in recognizing runaway trim conditions and to familiarize you with the handling characteristics of the aircraft with full trim deflection. Your IP will have you fly at cruise airspeed in straight-and-level flight while inducing full aileron trim deflection. After noting the control pressures necessary to maintain wings-level flight, slow to 110 to 150 knots and compare the control pressures at this reduced airspeed. After the aircraft is retrimmed for straight-and-level flight at cruise airspeed, repeat the demonstration using full elevator trim deflection. As your proficiency increases, your IP will induce simulated runaway trim conditions while you are flying at various attitudes and airspeeds between 100 and 200 knots. You will be required to recognize the runaway trim condition, maintain aircraft control, and take proper actions.

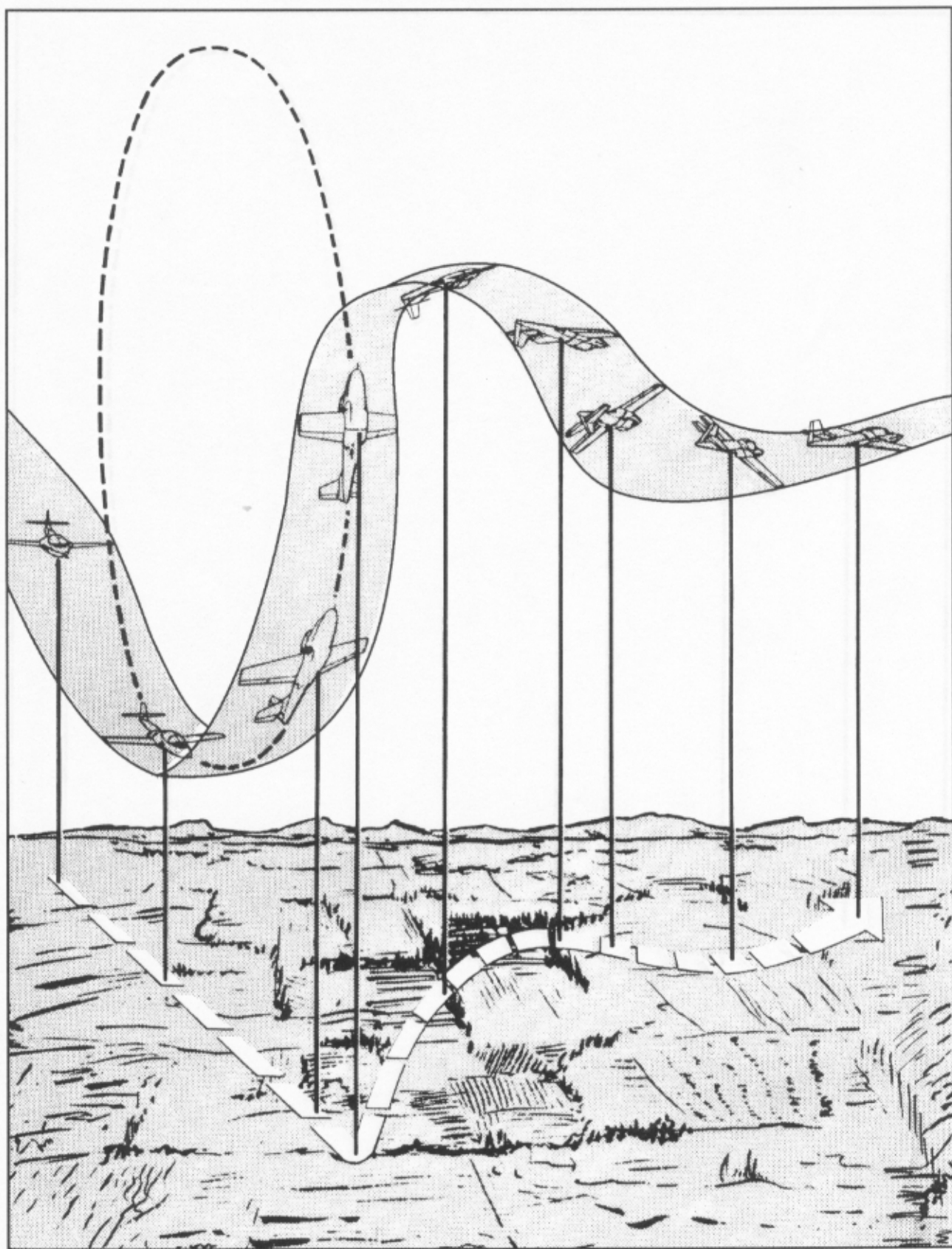


Figure 5.4. Nose-High Recovery.

Section C—Aerobatics

5.13. Performing Aerobic Maneuvers. Aerobic maneuvers help you develop and perfect your technique for operating an aircraft to obtain maximum flight performance. These maneuvers are smoothly executed and explore the entire performance envelope of the aircraft. You will learn aerobic maneuvers to help you develop a more sensitive feel for the aircraft and to improve your ability to coordinate the flight controls and remain oriented, regardless of attitude. You will also learn to put the aircraft where you want it. Learning to perform aerobatics skillfully will increase your confidence, familiarize you with all attitudes of flight, and increase your ability to fly an aircraft throughout a wide performance range. Aerobatics will also teach you to feel at ease when your body is oriented at any angle. You will realize that you can think, plan, observe, and perform as easily inverted as upright.

5.13.1. Training emphasis is on smoothness and proper nose track during the maneuver rather than on meeting exact entry parameters. Do your part to prevent loss of consciousness (LOC) episodes by avoiding unexpected, rapid, or abrupt control inputs when you are flying the aircraft.

5.13.2. You should normally use the specified entry parameters for aerobic maneuvers, but you may make small adjustments to entry airspeeds and power settings when this would enhance energy planning or expedite the profile flow (table 5.1). *Exception:* Use military power for over-the-top maneuvers (loops, Cuban eights, and Immelmans).

5.13.3. Continually strive for precision when flying these maneuvers. Normally, your left hand is on the throttles and your right hand is on the control stick. Avoid the use of a two-handed stick technique to maintain a wings-level attitude. Conscientious practice of these maneuvers will pay big dividends in providing knowledge of control pressures, timing, and planning, all of which are necessary for precision flying. The minimum altitude for entry or recovery from aerobic maneuvers is 5,000 feet above the terrain.

5.13.4. Before performing these maneuvers, ensure loose equipment is stowed and the boost pump is operating. If flown in a series, you do not have to check these items between individual maneuvers. Ensure the area is clear, and attain the entry airspeed for the maneuver.

5.14. Increased G Maneuvering. During aerobic flying you will perform maneuvers at different and ever-changing G levels. This is especially true of any maneuver that starts with extreme nose-down

attitude at low airspeed and transitions to increasing airspeeds and higher G loads, such as nose-low recoveries, spin recoveries, and split-S maneuvers. To maintain maximum alertness and avoid grayout, blackout, or loss of consciousness during aerobic flight, an effective anti-G strain is essential.

★**5.14.1. Anti-G Straining Maneuver (AGSM).** It is important to start the AGSM before the onset of the G forces and maintain the strain throughout the period of increased G loading. The amount of strain required will vary with the amount of applied G force. When encountering high G situations, all elements of the AGSM are required. During an AGSM, anticipation of the necessary strain, full muscle contraction, and constant breathing cycles become vital. Lower G situations will still require all elements of a full AGSM, but at a lower level of strain intensity. Your instructor will provide guidance on how to properly accomplish the AGSM and will ensure you can perform it properly.

★**5.14.1.1.** Accomplish the AGSM by firmly contracting muscles of the legs, abdomen, and chest. As the amount of Gs increases, you will need to increase the intensity of the strain and try to exhale through a closed airway. Continue to strain and simultaneously breathe approximately every 2 to 3 seconds. Think about the AGSM as a continuum. As the amount of Gs increases, and you increase the intensity of the strain, pay careful attention to proper breathing techniques. It is important not to hold the strain too long without breathing because this will reduce G tolerance. If grayout occurs at the onset of G forces, application of the AGSM may not eliminate the grayout. If altitude and (or) airspeed are not critical, return to one G flight, reapply the anti-G strain, and then continue maneuvering. Use caution not to exceed aircraft limits or your personal G-limit for the particular day.

★**5.14.1.2.** Remember, while flying aerobic maneuvers you will be exposed to different G levels. By anticipating these Gs early and performing the AGSM properly, you may avoid grayout, blackout, and loss of consciousness.

★5.14.2. AGSM Demonstration:

★**5.14.2.1.** Your IP will perform an AGSM demonstration to allow you to practice your anti-G strain technique and familiarize you with increased G flight. The demonstration will consist of a series of turns, each at a constant G level, with a break between turns for critique and rest. The maneuver will be flown at gradually increasing G levels, starting at two Gs and increasing to four Gs depending on your proficiency.

★ TABLE 5.1

SUMMARY OF AIRSPEEDS AND POWER SETTINGS FOR AEROBATICS

I T E M	A	B	C
	Maneuver	Airspeed (KIAS)	Power Setting
1	Split S (see para 5.18)	120	Idle to 90% RPM
2	Aileron Roll (see para 5.17)	220	90% RPM
3	Barrel Roll (see para 5.20)		
4	Lazy Eight (see para 5.22)		
5	Chandelle (see para 5.19)		
6	Cloverleaf (see para 5.21)	250	MIL
7	Loop (see para 5.16)		
8	Immelmann (see para 5.23)		
9	Cuban Eight (see para 5.24)		

★5.14.2.2. Your IP will advise you before maneuvering to ensure you are prepared. If at any time you approach your G tolerance, tell your instructor. It is important that the demonstration be of sufficient duration to ensure you can perform the AGSM properly. The AGSM cycle should last a minimum of 10 seconds (at least 4 to 5 breathing cycles).

★5.14.3. G-Awareness Exercise. If an AGSM demonstration is not done, perform a G-awareness exercise before flying any maneuver that may result in increased Gs. The G-awareness exercise should be a level or slightly descending turn using military power. Begin the maneuver with sufficient airspeed to sustain 4 Gs. G onset should be slow and smooth, allowing sufficient time to evaluate the effectiveness of your AGSM and determine your G tolerance. Increase Gs to approximately 4 Gs and maintain for approximately 10 seconds (4 to 5 breathing cycles) in order to allow full cardiovascular response. If you begin to grayout during the maneuver, return to one G flight, reevaluate your strain, and then slowly and smoothly reenter the G-awareness exercise.

5.15. Energy Maneuvering. A good knowledge of energy planning will enhance your ability to use time, fuel, and an assigned altitude block. Total energy is a combination of altitude and airspeed; one can be traded for the other. To trade altitude for airspeed, lower the nose and set military power. Commonly used references are canopy bow on the horizon or mag compass on the horizon. Using military power, you will gain approximately 50

knots for every 1,000 feet of altitude. One effective way to trade airspeed for altitude is to use military power and approximately 20° nose high with wings level. The ideal energy level occurs near the middle of the altitude block at 150 to 200 knots. You can perform any aerobatic maneuver from this energy level. Plan your maneuvers to flow from one to another. Spins, traffic pattern stalls, the cloverleaf, split S, nose-low recoveries, excessive Gs, and steep-banked turns are energy-losing maneuvers. Energy-gaining maneuvers include power-on stalls, the nose-high recovery, stability demonstration, and chandelle.

5.16. Loop. The loop is a 360° turn in the vertical plane (figure 5.5). Since it is executed in a single plane, the elevator is the basic control. The ailerons and rudder are used for coordination and directional control. The objective of the maneuver is to maintain a constant nose track.

5.16.1. To remain oriented, select a road or section line for a ground reference. Align the aircraft with the reference, and keep them aligned throughout the loop. Adjust the throttles to military, and attain the entry airspeed of 250 knots as you return to level flight.

5.16.2. Increase back pressure to pull the nose up at a constant rate. If you pull up too fast, you may exceed the critical AOA and stall. If your initial pullup is too slow, your airspeed will be slow over the top and you may stall. Centrifugal force will cause you to feel a definite seat pressure. Use this seat pressure (initially about 3 Gs on the

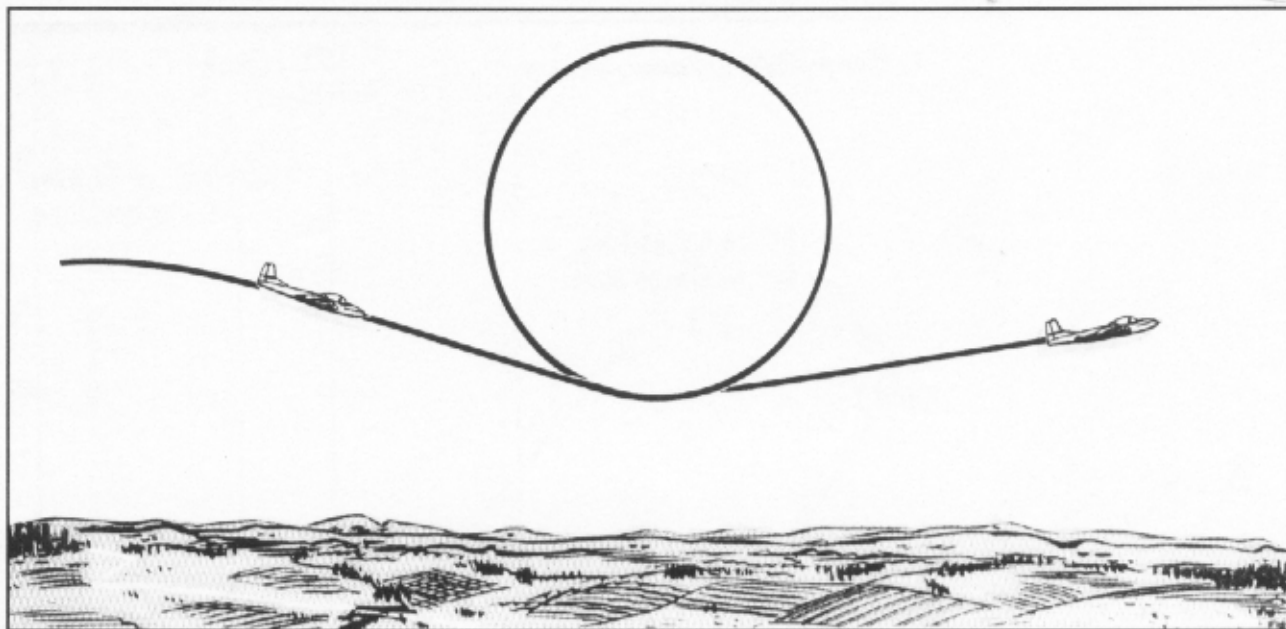


Figure 5.5. Loop.

accelerometer) to determine the correct rate of movement of the nose (for example, if there is very little seat pressure, your pullup is too slow). Maintain the initial rate of nose movement throughout the maneuver by adjusting back pressure. As airspeed is depleted in the pullup, less back pressure is required to maintain a constant rate of nose movement. Use aileron and rudder pressure to keep the wings level throughout the maneuver.

5.16.3. When you can no longer see the horizon ahead, look at the wingtips and keep them equidistant from the horizon. After passing the vertical flight position, tilt your head back and watch for the horizon to appear. Use the horizon to maintain a wings-level attitude. Locate the reference on the ground that you used to begin the maneuver.

5.16.4. As the inverted position is attained, release some back pressure in order to maintain a constant rate of nose movement. Use aileron pressure as needed to keep the wings level. As the nose passes through the horizon and the aircraft reenters a dive, increase back pressure to return to the level-flight attitude. Throughout the last half of the maneuver, use the ground reference to maintain the desired vertical plane. It is not necessary to complete the maneuver at entry altitude or airspeed.

5.17. Aileron Roll. The aileron roll is a coordinated 360° roll done in either direction. Adjust the throttles to 90 percent rpm, and attain the entry

airspeed of 220 knots. Smoothly raise the nose to 20° to 30° pitch attitude, relax back pressure, and initiate the roll by applying aileron and coordinated rudder pressure. After the aircraft begins the roll, continue coordinated control pressure to maintain the desired rate of roll. Make no attempt to keep the nose on a point. As you approach the wings-level attitude, gradually release aileron and rudder pressure to ensure a smooth coordinated return to wings level.

5.18. Split-S. The split-S demonstrates how much altitude is lost if recovery from inverted flight is attempted in this manner. It is basically the same as the last half of a loop except you are max performing the aircraft. Clear the area, keeping in mind that the aircraft climbs during entry and descends during recovery. From straight-and-level flight, set power between idle and 90 percent and simultaneously raise the nose to a 20° to 30° pitch attitude. When the airspeed approaches 120 knots, roll the aircraft to the wings-level, inverted attitude. From this attitude, apply back pressure to bring the nose through the horizon. Hold maximum back pressure without stalling the aircraft. The speed brake is optional throughout the maneuver. Airspeed and G loading will increase during the pullout. Remember to perform a proper anti-G strain. The maneuver is complete when the aircraft returns to level flight.

5.19. Chandelle. The chandelle is a precision 180° steep climbing turn with a maximum gain of altitude (figure 5.6). Use military power for the maneuver.

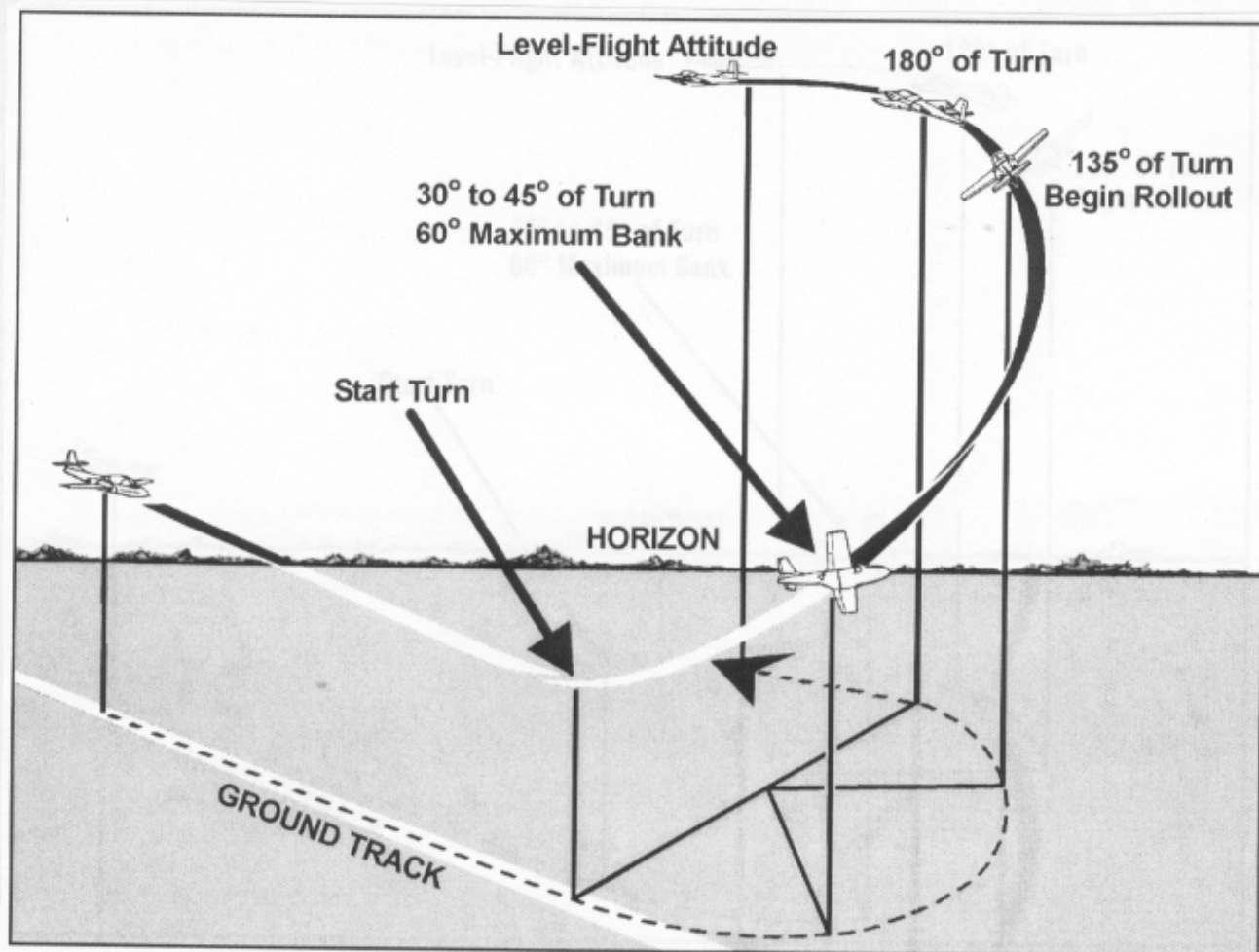


Figure 5.6. Chandelle.

5.19.1. Look in the direction of the turn, and clear while performing the maneuver. Enter the maneuver with the nose approximately 15° below the horizon. When the airspeed reaches 220 knots, blend rudder, aileron, and elevator pressure simultaneously to begin a climbing turn. Allow the bank to keep increasing and the nose track to keep rising at a uniform rate. The nose should describe a straight line diagonal to the horizon.

5.19.2. The nose of the aircraft should pass through the horizon between 30° to 45° of turn; and, at this point, you should reach a maximum bank angle of 60°.

5.19.3. Check the amount of turn by using outside references. Time the bank-and-pitch increase so that when the aircraft passes through level flight, your bank is approximately 60°. (Cross-check the attitude indicator and outside references.) At this point, the vertical component of lift decreases, which requires considerably more back pressure to keep the nose rising at a uniform rate. Continue to observe the amount of turn by checking outside

references. As soon as the 135° point in the turn is reached, start the rollout.

5.19.4. Allow the nose to continue to rise at a uniform rate. Some lift is gained by decreasing the angle of bank, and some lift is being lost by decreasing the airspeed. These variables require constant changes in control pressures to keep the nose rising at a constant rate.

5.19.5. Continue to observe the amount of turn remaining before reaching the 180° point by checking outside references. Time the rollout so the wings become level and the nose reaches the highest pitch attitude at the 180° point. Hold this pitch attitude momentarily. Cross-check outside references to maintain your heading. Lower the nose to level flight for the existing airspeed. Airspeed should be above a stall and sufficient to maintain altitude.

5.19.6. If the rate of climb is too fast, the aircraft will approach a stall before turning 180° and the maneuver must be discontinued. If the rate of pitch

change is too slow, the 180° point may be reached before the maximum pitch attitude is attained. If you plan to pull fast, roll in fast; if you plan to pull up more slowly, roll in slowly.

5.19.7. One point must be emphasized. When starting the maneuver, the rate of roll in is faster than the rate of pullup. The result is a greater change in bank than in pitch from the beginning to the completion of the maneuver. The bank will increase to 60° and then back to level. The total pitch change may only be 55° or 60°. The nose should describe a straight diagonal line to the horizon from the lowest point at the beginning of the maneuver to the highest point at the 180° position.

5.19.8. The maneuver should be timed so the nose will not have to be lowered to prevent a stall before the wings are leveled. After you level the wings, complete the maneuver by lowering the nose to level flight before a stall occurs.

5.20. Barrel Roll. A barrel roll (figure 5.7) is a coordinated roll in which the nose of the aircraft describes a circle around a point on the horizon. Maintain definite seat pressure throughout the roll. Practice the barrel roll in both directions. There is little or no net loss or gain of altitude from the maneuver.

5.20.1. Select a reference point on or near the horizon—a cloud or a landmark. Attain the entry airspeed of 220 knots by diving the aircraft while clearing. Attain this airspeed with the nose of the aircraft below the reference point. Use 90 percent power during the maneuver.

5.20.2. Begin a coordinated turn in the opposite direction of the desired roll. Keep the aircraft nose below level flight until it has turned 20° to 30° to the side of the reference point. Then begin rolling out of the initial turn, and allow the nose to rise so the wings are level just as the aircraft passes through a level-flight attitude. At this point, distance to the side of the reference point depends on the speed of the rollout. This distance from the reference point should remain the same throughout the barrel roll.

5.20.3. From level flight, continue with coordinated stick and rudder pressure, causing the climb and bank to increase. As the wings reach the vertical attitude, the aircraft should be at its highest pitch directly above the reference point. After you pass this position, relax some of the back pressure, but continue the roll by blending in more aileron pressure. If you hold the same amount of back

pressure as you did in the first quarter of the roll, you will put the nose down too fast in relation to the horizon because gravity is now assisting lift (downward). Plan the roll so the wings become level just as the aircraft reaches the inverted level-flight attitude. The aircraft nose track should now be the same distance on the opposite side of the reference point as it was at the beginning of the maneuver. The aircraft nose should have described a semicircle about the reference point. As the aircraft passes this position, continue the roll and begin applying increased elevator pressure.

5.20.4. As the wings again reach the vertical attitude at the bottom of the maneuver, the nose track should continue to be an arc of a circle with the reference point at its center. In this last quarter of the roll, you must begin to blend in more elevator and maintain coordinated control pressures to continue the roll so the nose track completes the circle around the reference point while positive seat pressures are held throughout the roll. The reason for blending in additional aileron pressure at the highest point of the roll is to maintain a constant rate of roll. Since the nose is rising continuously up to this point and the airspeed is decreasing, the aileron deflection is less effective than it was at the beginning of the maneuver. This means the rate of roll will slow down unless more aileron surface is presented to the relative wind. The rate of roll is held constant by the added aileron pressure.

5.20.5. These control effects apply to any rolling aerobatic maneuver, although they may be modified. It is the ailerons that roll the aircraft, and you should maintain a constant rate of roll throughout the maneuver. Do not over control with the rudder; use it only to maintain coordination. Throughout the maneuver, maintain coordinated flight and definite seat pressures.

5.21. Cloverleaf. The cloverleaf is composed of four identical maneuvers, each begun 90° from the preceding one (figure 5.8). The top part of this maneuver is similar to the recovery from vertical flight. The lower part resembles a loop. This maneuver will help develop your timing, planning, and coordination, using outside reference.

5.21.1. Perform the cloverleaf smoothly, without rapid rates of roll or excessive G forces. If possible, choose an area with section lines for easy reference. To begin the cloverleaf, adjust the throttles to military and attain the entry airspeed of 220 knots as the aircraft reaches level flight. The initial part of the maneuver is a straight pullup similar to a loop except for airspeed and lower G loading.

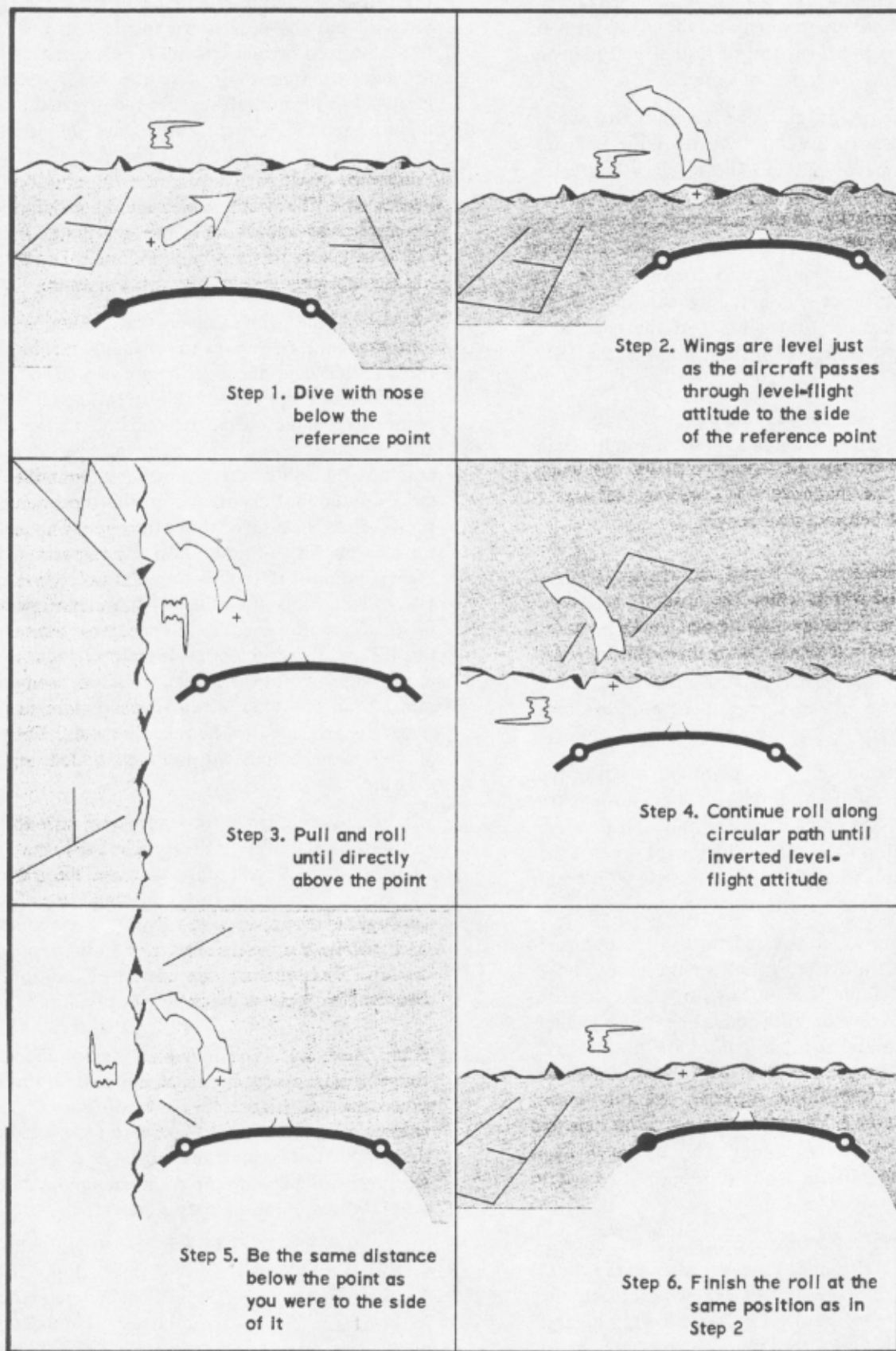


Figure 5.7. Left Seat View of Left Barrel Roll Around a Cloud.

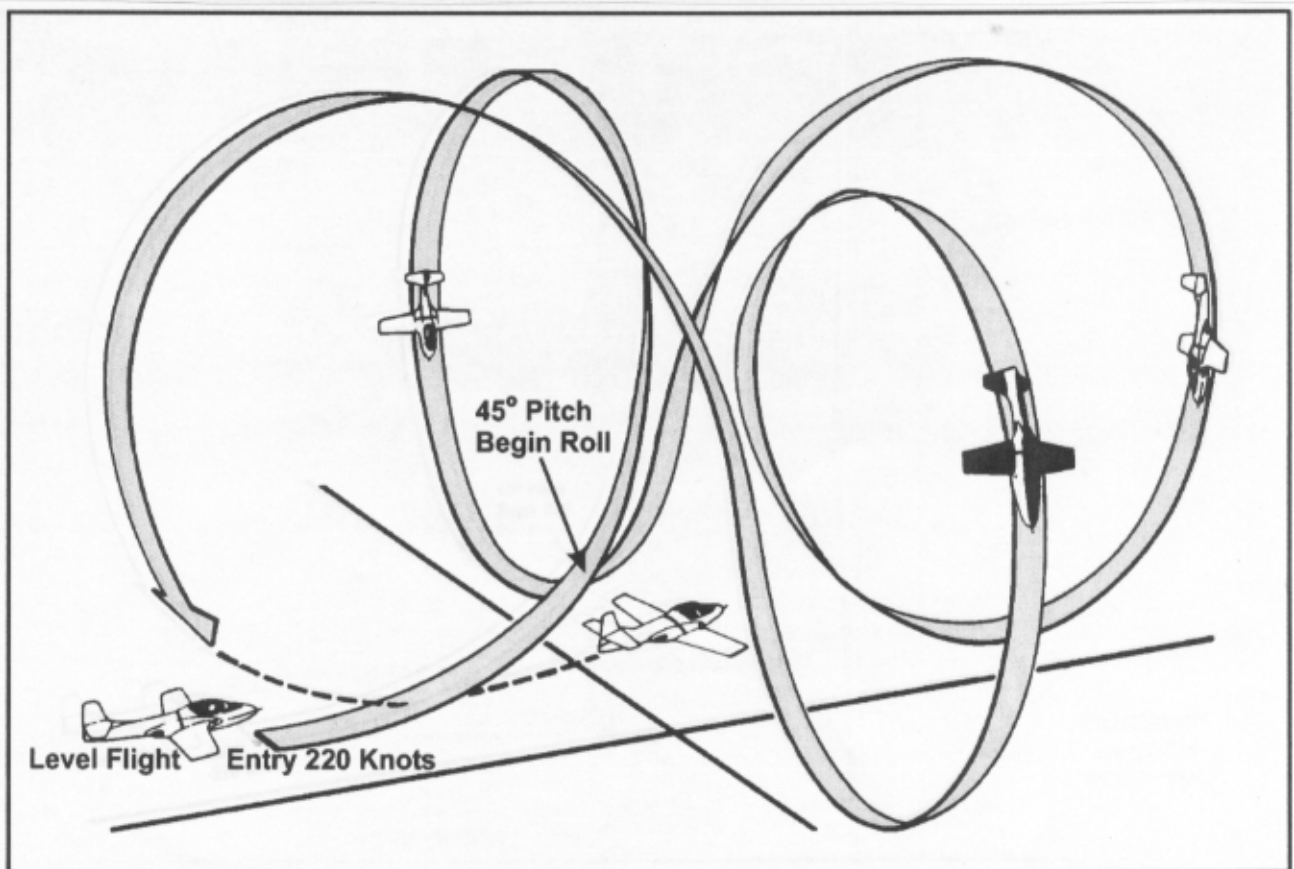


Figure 5.8. Cloverleaf.

5.21.2. Pick your reference point 90° from the nose. Start a climb and keep checking this point as you progress through the climb. As the aircraft reaches 45° of pitch, begin a coordinated roll toward the 90° reference point. Allow the nose to continue climbing during the roll so the maneuver is fairly slow and lazy. Your first objective is to climb and roll so the nose passes through the reference point with the aircraft at wings level, inverted, and at a relatively low airspeed. (Don't stare at the airspeed indicator, but check it as you pass through your selected point.)

5.21.3. As the aircraft is brought through the 90° point, keep the wings level and pull through the bottom of the maneuver. Plan the pull to reach level flight with 220 knots. To avoid excessive Gs at the bottom of the pull, apply more back pressure as soon as the nose track descends below the horizon and hold sufficient back pressure to keep the airspeed from building up too quickly during the initial part of the pullout. You may have to release some back pressure in order to reach entry airspeed. If you let the airspeed build up too fast, you will probably exceed 220 knots and find yourself pulling high G forces in the pullout. Use

increased back pressure early; do it smoothly and avoid the buffet range. Buffet will not hurt the aircraft, but it is poor technique.

5.21.4. Having completed one quarter of the maneuver, again select a point 90° from the nose and repeat the maneuver just described. Four complete loops in the same direction make the cloverleaf.

5.22. Lazy Eight. A lazy eight is basically a coordination exercise. It is a slow, lazy maneuver where the nose track of the aircraft describes a figure eight lying on its side at the horizon. The horizon line bisects this figure eight lengthwise. The maneuver includes a 180° change of direction and reversal, and it requires a continuous change of pitch and bank (figure 5.9).

5.22.1. To execute the lazy eight, you must use constantly changing control pressure. This is due to the changing bank, pitch attitudes, and airspeeds. As an aid to making symmetrical loops, you should select a prominent point on the horizon or a ground reference such as a section line or road from which you can mentally project an imaginary intersection at the horizon. The more references you use, the easier it is to perform good lazy eights and remain oriented in the area.

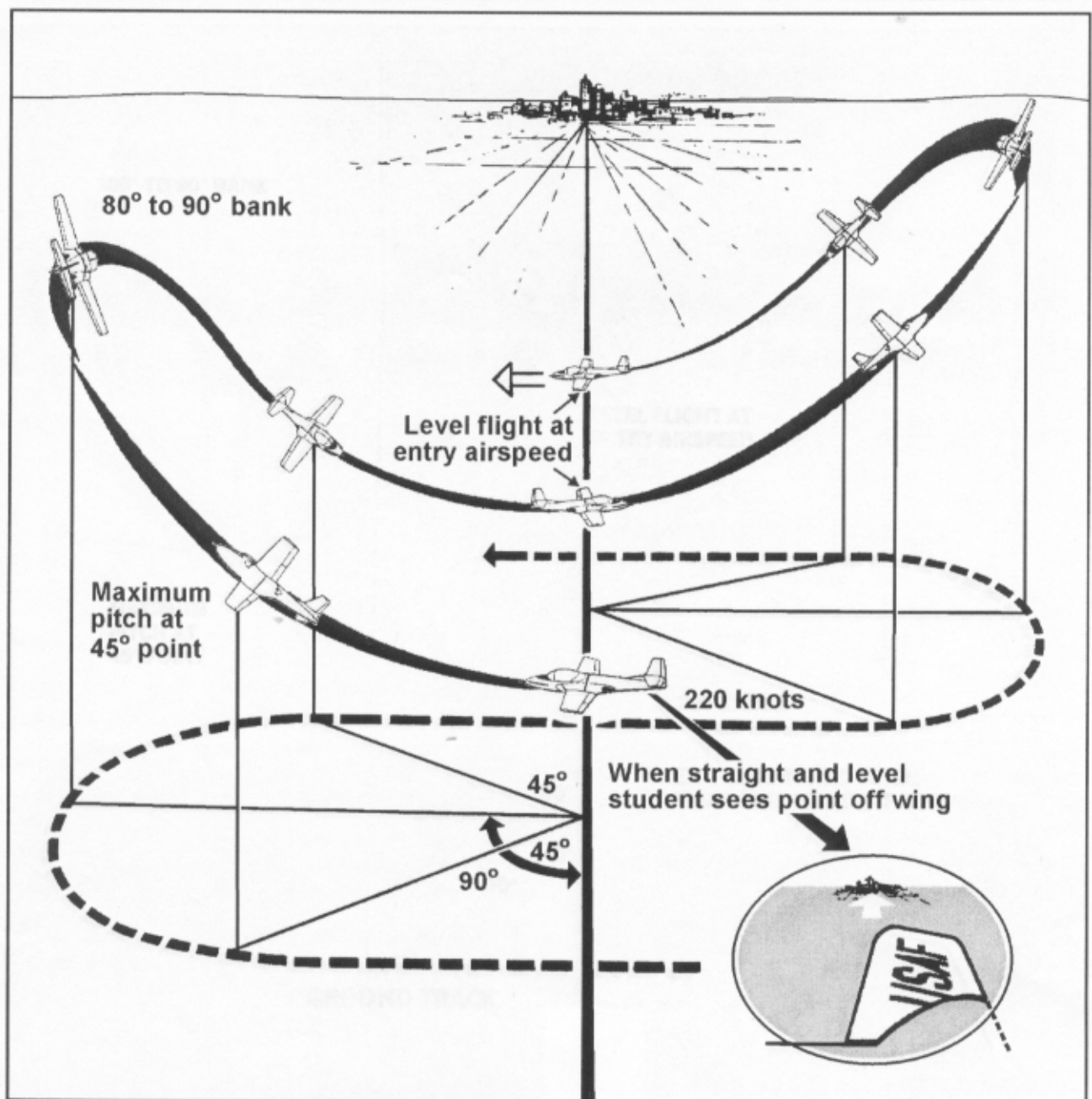


Figure 5.9. Lazy Eight.

5.22.2. Look in the direction of the turn, and clear while performing the maneuver. In straight-and-level flight with 220 knots airspeed and 90 percent rpm, select the desired reference point on the horizon. Align the aircraft so the reference point is directly off a wingtip. Blend aileron, rudder, and elevator pressures simultaneously to start a gradual climbing turn in the direction of the reference point.

5.22.3. The initial bank is very shallow to prevent turning too fast. As the nose is raised, the airspeed decreases, causing the rate of turn to increase. Also, as the bank is increased, the rate of turn will

increase. Time the turn and pullup so the nose reaches the highest pitch attitude when the aircraft has turned 45° or halfway to the reference point. Use outside references and the attitude indicator to cross-check these pitch-and-bank attitudes.

5.22.4. Do not hold the nose in this attitude, but lower it slowly to the horizon and toward the reference point. Continue to increase your bank to attain 80° to 90° as the nose reaches the horizon. Cross-check outside references and the attitude indicator for bank. The level-flight pitch reference point should reach the horizon at the 90° point.

Keep a check on the progress of the turn by checking outside references.

5.22.5. The lowest airspeed is encountered just as the nose reaches the horizon (approximately 100 knots below entry airspeed). Do not stop the nose at the horizon, but fly the aircraft into a descending turn so the nose track describes the same size loop below the horizon as it did above the horizon. When the nose track passes through the horizon, begin to decrease the bank gradually. When the aircraft has turned 135° , the nose should have reached its lowest attitude. The bank should diminish during the descending turn at about the same rate as it increased in the climbing turn.

5.22.6. At the 135° point, there is 45° of turn remaining before the aircraft reaches a level-flight attitude. Continue blending sufficient stick and rudder pressure to simultaneously raise the nose and level the wings. Monitor the progress of the turn by checking your outside reference point. Plan to arrive at the 180° point in level flight with entry airspeed. The wings should become level as the aircraft reaches the level-flight attitude at the 180° point.

NOTE: The beginning and ending of the maneuver are the only times the wings are in level-flight attitude.

5.22.7. Having completed half the eight, the opposite wing is now toward the reference point and the nose at the 180° point, with entry airspeed. Do not hesitate in straight-and-level flight, but begin another climbing turn in the direction of the reference point. This turn is opposite to the one used at the start of the maneuver. Fly the second 180° turn like the first.

5.22.8. Complete the maneuver with the aircraft headed in the original direction. Complete the maneuver in a slow, smooth, lazy manner without hesitation and with constantly changing control pressures and flight attitudes. Try to use outside references to fly a precise nose track that results in a symmetrical maneuver.

5.23. Immelmann. The Immelmann is a half loop followed by a half roll, all flown in the same vertical plane. To begin the Immelmann, adjust the throttles to military and select a ground reference, as explained in paragraph 5.16.1 for the loop.

5.23.1. Enter a dive to gain airspeed. Then pull up to level flight with the entry airspeed of 250 knots. Continue the movement of the nose by increasing back pressure. Maintain a constant rate of movement of the nose throughout the pullup (initially about 3 Gs on the accelerometer).

Maintain wings level with coordinated flight controls.

5.23.2. As the aircraft reaches a point approximately 20° above the horizon inverted, apply aileron in either direction to initiate a roll to level flight. Through the first portion of the roll, rudder should be opposite to applied aileron pressure. Rudder will be reversed and coordinated in the same direction as applied aileron in the last portion of the roll.

5.23.3. During the first half of the roll, relax some back pressure to keep the nose track in the same vertical plane. Increase this back pressure again as the level-flight attitude is approached because the nose will want to drop as the airspeed decreases. Increase the blended rudder pressure during the last part of the rollout to hold the nose in the vertical plane. The maneuver is complete after a momentary pause in level flight following the rollout.

5.24. Cuban Eight. Each half of this maneuver is a slightly modified combination of the loop and the Immelmann. It is approximately the first ~~three~~ ^{eight} ~~quarters~~ ^{fifths} of a loop followed by a half roll. It is then repeated in the opposite direction (figure 5.10).

5.24.1. Adjust the throttles to military, and begin the maneuver by making a normal loop entry at 250 knots. Proceed over the top. After passing through inverted level flight, relax back pressure approaching 45° below the horizon and execute a half roll in either direction. Use rudder pressure as in the Immelmann to hold the aircraft on the desired heading. Release the elevator pressure to keep the nose track in the same vertical plane.

5.24.2. After completing the half roll, plan your pullup to attain 250 knots when passing through level flight. Continue the pullup into another loop entry. The second half of the Cuban eight is identical to the first except the roll is in the opposite direction. The maneuver is complete when you attain level flight at entry airspeed.

Section D—Spins

5.25. Spin Training. A spin is an aggravated stall resulting in autorotation. The aircraft describes a corkscrew path in a downward direction. Although both wings are stalled, one wing has more lift than the other. Gravity forces the aircraft down, rolling and yawing in a spiral path. Spin training will increase your confidence in the aircraft and improve your ability to orient yourself in any attitude.

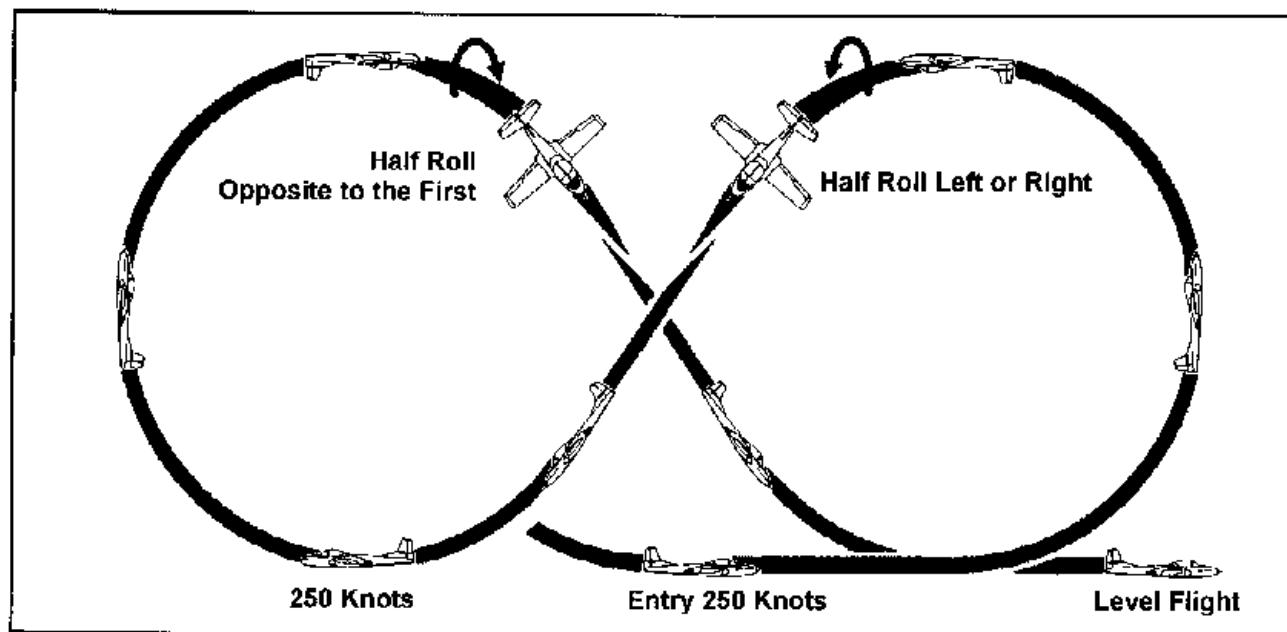


Figure 5.10. Cuban Eight.

5.25.1. Two conditions are necessary for the aircraft to spin, stall and yaw. Therefore, any time the aircraft is stalled, one of the conditions necessary for a spin exists. If rudder is displaced from neutral during a stall, rotation will result. An important thing to remember throughout your training is, if controls are held neutral and the aircraft is not allowed to stall, it will not enter a spin or aggravated condition regardless of airspeed.

5.25.2. The aircraft gives sufficient warning. It is very easy to recognize a stall and an approach to a spin. Your IP will emphasize the conditions that could result in a spin and give you concentrated practice in spin prevention.

5.25.3. To avoid inadvertent engine shutdown while performing a spin recovery or spin prevention from an intentional or unintentional spin, remove your hand from the throttles after the power has been checked in idle. You may resume control of the throttles after the spinning stops and the dive recovery has been initiated.

5.26. Stability Demonstration. This maneuver demonstrates that the aircraft will not enter a spin except from an aggravated stall. The first requirement for an aircraft to spin is a stall. As long as the aircraft is not allowed to stall, it will not enter a spin. Perform the prestall checks, adjust throttles to 90 percent, and clear the area. Raise the nose to a 70° pitch attitude. Your instructor will point out the references used to maintain this attitude. Control the direction of flight with the

rudder, and keep the wings level with ailerons. Hold this attitude constant until flying airspeed is depleted (below 50 knots). Initiate the recovery by neutralizing all controls. Allow the nose to lower until you feel positive pressures on the controls. This indicates the aircraft is regaining flying airspeed. Recover to level flight without stalling the aircraft. The maneuver is complete when you have returned to level flight.

5.27. Intentional Spin Entry:

5.27.1. Before entering any intentional spin, do the prespin checks and adhere to the spin restrictions in AETCR 55-37. Use power as required during the initial part of the pullup for spin entry. However, if any power setting above idle is used during the pullup, retard the power to idle before or at the first stall indication. Establish a nose-high pitch attitude of 15° to 50°. When more than 30° of pitch is used, establish a 20° to 30° bank in the direction of the spin before the stall occurs.

5.27.2. At the first stall indication, slowly and smoothly apply back stick and rudder in the desired direction of the spin. When the aircraft begins to stall, move the stick at a rate that will maintain a constant pitch attitude until the stick is all the way back. Apply rudder at a rate so full rudder occurs simultaneously with full back stick. Make sure you use full travel of the stick and rudder and hold the controls firmly against the stops with ailerons neutral.

5.27.3. As the aircraft becomes fully stalled, a variety of pitch oscillations may occur depending on pitch attitude, direction, and fuel weight at entry. As the aircraft progresses into a fully developed spin, these pitch oscillations dampen out. There is not a definite number of turns, pitch attitude, rate of rotation, or airspeed that can be used to describe a fully developed spin in all cases. You will learn to recognize a fully developed spin through demonstration, practice, and knowledge of spins. Normally, the following guides will help you recognize a fully developed spin: the nose remains below the horizon, but not necessarily at a constant pitch attitude; the rate of rotation is almost constant; and the airspeed oscillates slightly (usually below 50 knots).

5.27.4. From a fully developed spin, the aircraft will progress into a stabilized spin if the controls are held against the stops. There is not a definite number of turns, pitch attitude, or airspeed to describe a stabilized spin. A stabilized spin is normally characterized by a steady airspeed, constant rate of rotation, and constant pitch attitude (approximately 40° to 45° nose low). The altitude loss is approximately 550 feet per turn in a stabilized spin, and the duration of one turn is approximately 3 seconds.

5.28. Normal Spin Recovery:

5.28.1. Enter an intentional spin. As soon as the aircraft has progressed into a fully developed spin, proceed with the spin recovery procedures. (Do not wait for the spin to stabilize; this only results in excessive loss of altitude.)

5.28.2. Physically recheck that the throttles are in idle, rudder and ailerons are neutral, and stick is full aft.

5.28.3. Determine the direction of rotation, using the turn needle and outside references. Immediately after determining the direction of rotation, abruptly apply full rudder opposite the direction of the spin (opposite the turn needle) and hold. Do not wait for prominent landmarks before applying recovery rudder.

5.28.4. One turn after applying recovery rudder, abruptly move the stick full forward. As the nose pitches down near the vertical, neutralize the elevator while continuing to hold rudder until spinning has stopped. Do not allow the stick to move aft of neutral until recovery is effected. After the rotation is definitely stopped, neutralize the rudder and recover from the ensuing dive.

5.28.5. Do not bounce the stick off the forward stop or ease the stick forward, assuming the aircraft

will recover. The primary objective is a positive recovery, not a smooth one.

5.29. Spin Prevention. The spin prevention is similar to a power-on stall recovery except the aircraft has started to rotate. This maneuver is designed to teach you to recognize and recover from a developing spin condition. Also, it will show you what may occur when stall recovery or spin prevention procedures are delayed. Your IP will have you initiate spin prevention procedures at varying degrees of rotation, but before stabilization.

5.29.1. Perform an intentional spin entry. Before stabilization, initiate the spin prevention by simultaneously using stick forces as necessary to break the stall, applying rudder as necessary to eliminate the yaw, and physically checking the throttles in idle. Use ailerons to stop the roll only after the stall is broken, and then return the aircraft to level flight.

5.29.2. The degree of control deflection necessary to prevent the spin depends on how far the spin has developed. In some cases, full control deflection may be required. Do not use abrupt control movements, but use the controls positively. As the controls are applied, the rate of rotation may increase until the controls become effective. Applying stick forces as necessary to eliminate all stall indications is imperative because any degree of stall will reduce the possibility of a successful spin prevention. If full prevention controls (rudder and elevator) are applied, the nose remains below the horizon, and the rotation stabilizes at an increased rate, the spin has developed too far for spin-prevention procedures to be effective. Consequently, a spin recovery will be necessary. Spin-prevention procedures are most effective when employed at the early stages of spin development. Stall and yaw conditions are easily controlled, rotation is slow, and the recovery is almost instantaneous. However, aircraft response to spin-prevention control inputs becomes slower as the spin nears full development. When this happens, increased time is necessary for the controls to become effective, rotation is more pronounced, and the nose may lower to the vertical attitude. At this point, a successful recovery is usually imminent. However, if the rotation stabilizes at an increased rate, the spin has developed too far for an effective spin prevention.

5.30. Inadvertent Spins. It is important to realize that inadvertent spin entries are often more disorienting and oscillatory than planned entries. Also, the parameters in paragraphs 5.27.3 and

5.27.4 for rotation rates, descent rates, and pitch attitudes apply only to stabilized normal erect spins. Depending on control position, inadvertent spins may be accelerated and these parameters can vary. However, the spin prevention and spin recovery procedures are extremely reliable. Spin prevention will fail only if the spin is excessively accelerated due to control position and delayed initiation or due to slow control applications. The spin recovery procedure will always be effective if you perform it properly.

5.30.1. If you suspect an inadvertent spin, immediately employ the spin prevention. Control pressures may differ from those experienced during practice spin preventions because of the position of elevator trim or aircraft configuration. Therefore, be sure to use sufficient deflection to break

the stall, control the yaw, and stop the roll. Inadvertent spin entries can result in severe pilot disorientation. In these situations, spin recovery procedures should be immediately employed. Under these conditions, using spin-recovery procedures will ensure a positive recovery and be more effective than a spin prevention.

5.30.2. If a landing configuration spin is inadvertently entered, immediately apply spin-prevention procedures. If full prevention controls (rudder and elevator) have been applied, the nose remains below the horizon, and the rotation stabilizes at an increased rate, then execute the spin recovery. Gear and flaps should be retracted as soon as possible after rotation stops to prevent excessive structural loads.

Chapter 6

TRAFFIC PATTERN AND LANDING

6.1. General Guidelines. You will do most of your flying in the T-37 at the home base and auxiliary field. Due to the number of aircraft operating at these locations, every pilot must conform to established procedures and a standardized traffic pattern. The runway is the primary reference in the traffic pattern. Your IP will provide ground references at these fields to fly the patterns for existing conditions. You should learn how to adjust for winds and how to determine universal references that will work at any field. Use these references as aids in developing the judgment required to accurately estimate distances and glide path. The radio calls in this chapter are standard calls in the UPT environment. When not flying in this environment, use local procedures or standard Air Force terminology, as appropriate.

6.2. Letdown. The letdown is primarily used to descend to traffic pattern altitude. Plan the letdown to enter the traffic pattern or to comply with approach directives. To begin a letdown, simultaneously lower the nose and adjust the power as necessary. The speed brake is optional. The airspeed in the letdown is normally 200 to 250 knots or as directed by approach control (within safe limits). This allows you to concentrate on the outside references and clearing during the descent. An excellent technique to aid clearing during a VMC letdown is to use clearing turns. This also helps control descent rates. Your IP will demonstrate the proper letdown techniques. A good lead point will allow you to accomplish a smooth level off at the desired altitude. One technique for determining a lead point is to use approximately 10 percent of the VVI. As you approach the level off altitude, gradually bring the nose of the aircraft to the level-flight attitude, trim the aircraft, and adjust the power and speed brake as necessary.

6.3. Standard Overhead Pattern. The 360° standard overhead pattern is used to safely and properly handle a maximum number of aircraft with minimum congestion (figure 6.1). The pattern should be adjusted for existing wind conditions.

6.3.1. Before Traffic Entry. Before entering the traffic pattern, determine the landing direction by monitoring the appropriate radio frequency and watching other aircraft. If you are not sure of the direction of traffic, obtain landing instructions from the RSU, tower, or other controlling agencies. When the RSU or tower broadcasts runway winds,

keep this information in mind. This information directly affects how you fly the traffic pattern. Local regulations define the traffic pattern entry procedures. You must adequately clear while descending to enter traffic.

6.3.2. Initial Approach. When turning onto initial, plan the rollout so your ground track is aligned with the runway center line or as directed. Altitude is normally 1,000 feet above the terrain and airspeed is 200 knots. Call initial to the controlling agency as directed, and state your fuel remaining if you plan a full stop. Also call no flap or zero flap if practicing these types of landing. The break is normally performed between approach end and 3,000 feet down the runway. The exact point of the break is affected by existing wind conditions and traffic saturation. When a T-37 on a straight-in approach is between 5 and 2 miles, do not initiate the break unless the controller allows you to do so because the two aircraft would be in conflict on final. To accomplish the break, smoothly roll into a bank of approximately 60°. The angle of bank and amount of back pressure will vary according to wind conditions. Adjust the throttles as required to slow the aircraft to 120 to 150 KIAS. Continue the level turn and rollout on the downwind with the necessary drift correction to maintain a flight path parallel to the runway. During normal overhead patterns the speed brake is lowered when rolling out on the inside downwind. However, strong headwinds or spacing requirements may require speed brake extension in the break.

6.3.3. Downwind Leg. As you roll out on the downwind, extend the speed brake. When the airspeed is 150 knots or below, lower the landing gear and make all gear-down checks. Use power as necessary to maintain airspeed and altitude. The minimum airspeed on the downwind leg is 120 knots. As airspeed decreases to 120 knots, you will have to retrim the aircraft and increase the pitch attitude to maintain level flight (horizon line approximately $\frac{1}{4}$ up the wind screen). With the speed brake and gear extended, approximately 82 percent rpm on both engines will maintain 120 knots.

6.3.3.1. After the gear is lowered and checked down and airspeed is 135 knots or below, place the wing flap lever in the down position before you begin the final turn. Check the indicator to

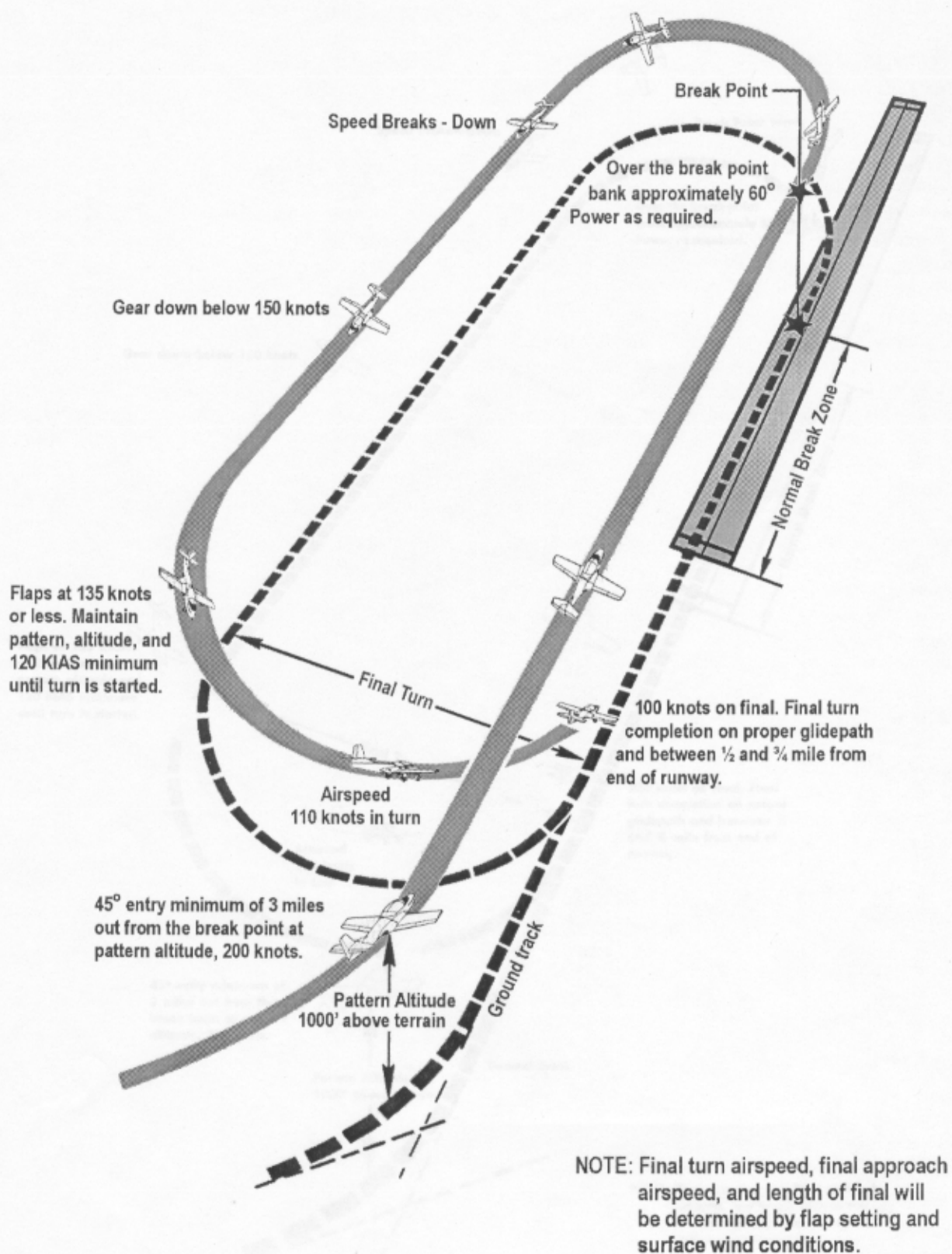


Figure 6.1. Normal Traffic Pattern.

ensure the flaps have started to lower. Fly normal patterns using full flaps.

6.3.3.2. Do not start the final turn in the following cases: (1) if there is another aircraft in the final turn and not in sight, (2) if there is a straight-in inside of 2 miles and not in sight, or (3) if you cannot maintain normal pattern size and safe spacing. If you do not have the aircraft in front of you in sight, break out from the downwind leg using local procedures.

6.3.4. Final Turn. The final turn begins as you initiate the turn from the downwind leg. The turn is complete when the wings are level on final approach. Plan the final turn to rollout on final approach with a 4° glide path. This equates to approximately 300 feet above the terrain at ¾ mile from the approach end of the runway. The rollout on final can vary between ½ to ¾ mile from the runway. Adjust the altitude lost during the final turn to establish a good glide path.

6.3.4.1. Adjust the turn point for the existing wind condition. If a strong tailwind exists on downwind, remember this will blow the aircraft from the approach end and a long final will result if the turn is started at the normal position. Before beginning the final turn, it will be helpful to pick a specific rollout point on the ground. Begin your turn to final to arrive wings level on final over this point.

6.3.4.2. Starting the final turn, simultaneously lower the nose of the aircraft and roll into approximately 30° of bank. When the bank and pitch are set, the horizon should be in the upper one-third of the windscreen.

★6.3.4.3. After starting the final turn, slow to 110 knots and trim the aircraft. Make a gear down call to the controlling agency as soon as safely possible after confirming your configuration.

6.3.4.4. In the final turn, divide your attention between the airspeed indicator, rollout point, and runway. Visualize and project your descent angle around the final turn, over the rollout point, and down the final approach. The descent angle, projected to the ground, will be to a point just short of the intended touchdown point. Because of crosswinds, it may be necessary to vary bank angle in the final turn. You may increase the bank up to 45°, but remember that the stall speed of the aircraft will increase. If you have any doubt about the safety of continuing the approach, go around.

6.3.5. Final Approach. The final approach begins when the wings are level after the final turn. On final approach, slow to and maintain 100 knots and trim. Check your spacing with the aircraft ahead of you on final approach. If it appears you will not be able to land with proper spacing, anticipate the need to go around and make a timely decision.

6.3.5.1. After rolling out on final and aligned with the runway, you have two objectives. The first is to maintain runway alignment; the other is to maintain a smooth, constant glide path to round out and touch down.

6.3.5.2. The pitch attitude on final approach is slightly shallower than the pitch attitude in the final turn. Consequently, you must raise the nose of the aircraft to establish the correct glide path. A good final approach pitch reference is the runway threshold halfway up the windscreen. Plan to maintain a minimum of 50 percent rpm on final.

6.3.5.3. On final approach, as in the final turn, the aircraft is affected by wind, but the flight path must coincide with the desired ground track. Because there is almost always a wind condition that is less than optimum (blowing straight down the runway), you may need special techniques to maintain runway alignment. There are two ways to do this, the wing-low method and the crab method. In the T-37, use the crab method as you roll out on final. Then transition to the wing-low method. The normal inclination is to automatically roll out of the final turn with a crab into the wind (figure 6.2).

6.3.5.4. Rolling out on final with a crab into the wind indicates how much control deflection is needed for transition to the wing-low method. Set

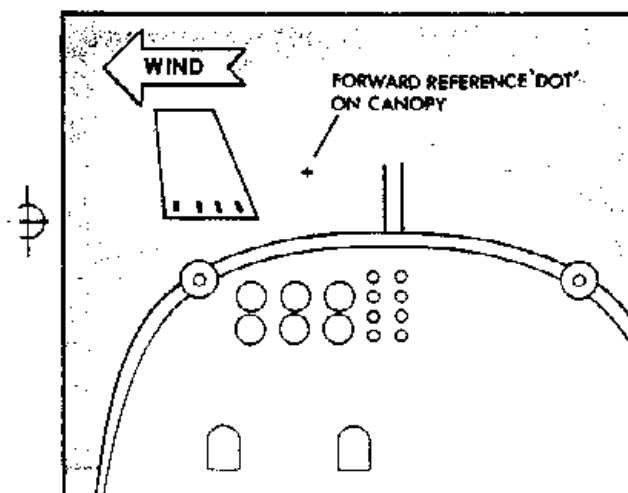


Figure 6.2. Crab Into the Wind.

up the wing-low crosswind approach shown in figure 6.3. (The T-37 landing gear struts are not stressed to continually withstand the side loads imposed by a crab landing.)

6.3.5.5. The proper method for using crosswind controls is to apply sufficient rudder deflection to align the longitudinal axis of the aircraft with the runway. Use aileron as necessary to keep the flight path aligned with the runway. Maintain airspeed by increasing the power to compensate for the increased drag caused by crosswind controls.

6.3.5.6. The second and most difficult objective is visualizing a constant glide path to the roundout and touchdown position. In the normal landing configuration (full flaps), the T-37 flight attitude is such that the aircraft is aimed (putting the level flight horizon reference) at a position (aim point) short of the intended touchdown point (figure 6.4). You should aim short of the intended touchdown point because of the delay during the roundout. Plan to touch down within the first 1,000 feet of the runway. This does not mean that routinely landing in the first few feet or 1,000 feet down the runway is acceptable. Your main objective is to strive for a touchdown with the proper landing attitude at a point on the runway that provides an adequate safety margin against landing short, yet allows the aircraft to easily stop within the available runway. In determining your aim point, consider all factors such as wind, runway length, aircraft weight, flap setting, etc.

6.3.5.7. Frequently check the airspeed on final approach. Because the T-37 engines accelerate

slowly, plan the pattern to maintain a minimum of 50 percent rpm on final until the landing is ensured.

6.3.5.8. If you land in a gusty wind condition, use half flaps and increase final approach airspeed to 110 knots. Half flaps provide better control. The aircraft may float farther than normal before touchdown because of the configuration and extra airspeed.

6.3.5.9. There are several differences between a heavyweight and lightweight aircraft during final approach. Although minimum airspeeds remain the same, lift requirements change with differences in aircraft gross weights (fuel on board). A heavyweight aircraft has a higher lift requirement and will develop a sink rate quicker than a lighter aircraft. This sink rate can only be stopped with combined corrections of pitch and power. At heavier weights, the added lift requirement increases the amount of time between power application and the effect of this power application in stopping the sink rate. In addition, the higher stall speed will decrease the time lapse between a pitch increase and the actual stall. In the T-37, stopping a sink rate is a problem due to slow engine acceleration. During a no flap, the power setting will be lower than during a normal pattern due to the decrease in drag devices. This is important because when the power is back, it takes longer for the engines to accelerate when the throttle is moved forward. Adhere to minimum airspeeds, plan the pattern to avoid high sink rates, and recognize extra time is required to stop a sink rate as it develops on final.

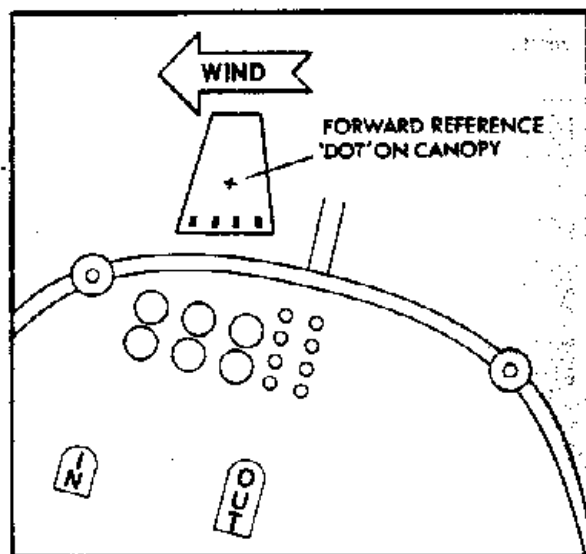


Figure 6.3. Wing-Low Crosswind Approach.

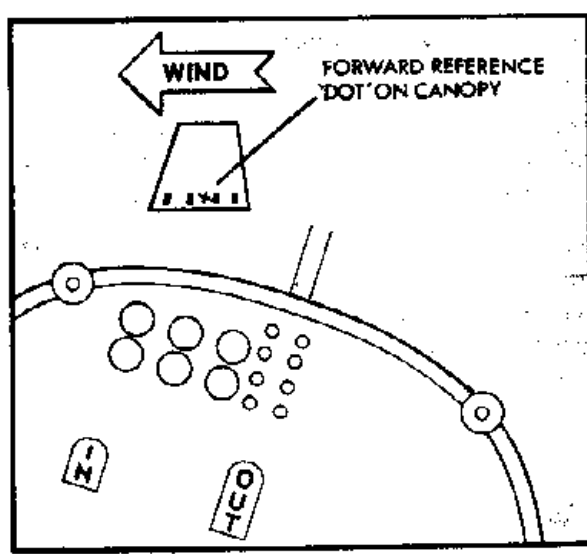


Figure 6.4. Aiming Short of Touchdown Point.

6.4. Normal Landings. So you can better understand the factors affecting your judgment and pilot technique, the landing is divided into three phases; roundout, touchdown, and landing roll.

6.4.1. Roundout. During the roundout, decrease the rate of descent as you approach touchdown. Smoothly continue back pressure to increase the pitch attitude until the proper landing attitude is reached. When making a roundout, you are decreasing the airspeed so the aircraft will settle gently onto the runway. Retard the throttles to the idle position at or before touchdown.

6.4.1.1. Different rates of descent will cause the height of the roundout to vary. Execute a high roundout more slowly than a lower roundout to allow for greater loss of altitude. Make the roundout proportionate to the apparent rate of descent. Your IP will show you the height to start a roundout with different rates of descent.

6.4.1.2. Throughout the roundout, be aware of the effects of crosswinds. If crosswinds exist, you must use crosswind controls throughout the roundout. As the airspeed decreases to just above the stall, you may need additional aileron and rudder deflection. If the control surfaces are deflected out of their normal streamlined position, they will add drag, airspeed will dissipate much faster, and stall speed will increase. Use caution during gusty wind conditions for rapidly changing wind direction and velocity. Timely control inputs are needed to maintain directional control.

6.4.1.3. Power can be used effectively during the roundout to compensate for errors in judgment. Any time the controls feel mushy or you feel approach-to-stall indications you learned from traffic pattern stall training, apply power and execute a go-around. This will cushion any ensuing touchdown. If it appears that you are going to land excessively long, do not hesitate to go around.

6.4.2. Touchdown. The touchdown is the gentle settling of the aircraft onto the runway in the landing attitude. Continue to hold any crosswind control deflection used during the roundout. If you do not, the aircraft will crab into the wind and you will touch down in a crab. When using crosswind controls, expect one main gear to touch down before the other. If crosswinds are not significant, maintain the landing attitude after touchdown. This will require increasing backstick pressure as airspeed dissipates. Leave flaps down and speed brake and thrust attenuators extended to take advantage of increased drag and reduced thrust. Lower the nose wheel to the runway while there is still sufficient elevator control and before

reaching minimum nose wheel touchdown speed. Avoid lowering the nose wheel abruptly. If the nose wheel contacts the runway on touchdown, leave it there. Attempts to lift it off at high speeds may cause the aircraft to become airborne with a dangerously high AOA. If power was used during the roundout to decrease the rate of descent or prevent a stall, retard the throttle to idle upon touchdown so the aircraft will stay on the ground.

6.4.3. Landing Roll. After the nose wheel is on the runway, retract the speed brake unless maximum braking is desired. Initially, directional control is maintained with rudder and (or) brakes.

6.4.3.1. Normally, avoid nose wheel steering until the aircraft has slowed to normal taxi speed. When you engage the nose wheel steering, center the rudder pedals before depressing the nose wheel steering button. At high airspeeds, nose wheel steering is extremely sensitive and easily over controlled. Before reaching taxi speed, you should use nose wheel steering only if you are unable to maintain directional control with the rudder and brakes on the landing roll. If you encounter nose wheel shimmy during the landing roll, continue to apply forward stick pressure to place more weight on the nose gear.

6.4.3.2. Familiarize yourself with the factors that influence the controllability of the aircraft after the landing. Some of these factors are the center of gravity, strong crosswinds, a low strut, and a slippery runway. As you slow down, your flight controls lose their effectiveness, thus increasing the effect of the crosswind. The T-37 has more surface area behind the main landing gear than in front. After the aircraft is on the ground, the main landing gear is the fulcrum point, and the impact of the crosswind on the side area will cause the airplane to act as a weather vane and turn into the wind. You can see how important it is to use rudder and (or) brakes to maintain directional control during the landing roll.

6.4.3.3. You must also use aileron to prevent the crosswind from lifting the upwind wing. If you use too much aileron, the other wing will start to rise; but at the time rudder effectiveness is lost, full aileron deflection may be necessary.

6.4.3.4. During any ground roll, you can change direction by applying pressure on a single brake or uneven pressures on both brakes. You must use caution when applying the brakes to avoid over controlling. To use the brakes, slide your feet up on the rudder pedals so toe pressure can be applied to the top of the pedals. If rudder pressure is being held at the time the brakes are needed, try to hold

the rudder pedals in position as you slide your feet up. The brakes work independently of rudder pedal position. For instance, it is quite possible to hold right rudder and left brake, although such a requirement is not likely.

6.4.3.5. Later in the landing roll, use the brakes to slow the aircraft. Apply smooth and continuous pressure until the aircraft slows to taxi speed. Do not brake to a near halt and then taxi with power for the remainder of the landing roll. Nose wheel steering is not normally necessary until the aircraft has slowed to normal taxi speed. Center the rudder pedals before depressing the nose-wheel steering button.

6.4.3.6. At the end of the landing roll, clear behind you and turn off the taxiway. It is permissible to raise the speed brake during the rollout, but do not complete any other checklist items until you are clear of the runway. Concentrate on maintaining directional control and slowing the aircraft to a safe taxi speed. While taxiing to the parking area, you may shut down the ramp-side engine. When an engine is shut down, check the hydraulic pressure. If hydraulic pressure is lost, stop the aircraft on the taxiway, shut the other engine down, and have the gear safety pins installed before the aircraft is towed to the parking areas.

6.5. Touch-and-Go Landings. For touch-and-go landings, simultaneously retract the speed brake and smoothly apply power as soon as the main gear touches down. Hold the nose wheel off as long as airspeed does not decrease below nose-wheel touchdown speed. Maintain directional control with rudders. Lower the nose slightly from the landing attitude to the takeoff attitude as the throttles are advanced. Coordinate pitch and power so the aircraft will not become airborne prematurely with too low an airspeed. After becoming safely airborne, perform the after-takeoff checklist.

6.5.1. If it appears you are going to land long, advance the power and go around. Because the T-37 accelerates slowly, the aircraft may continue to settle and touch down. In this event, do not try to hold the aircraft off the runway in a nose-high attitude. Maintain a landing attitude, and allow a normal touchdown.

6.5.2. If you have trimmed the elevator properly on final approach, the back trim will tend to fly the aircraft off as flying speed is attained. You may have to use forward stick pressure to compensate for the tendency of the nose to pitch up, but the force is not strong. Do not retrim the elevator during the ground roll.

6.6. Single-Engine Procedures. Your IP will give you simulated single-engine practice by placing one throttle in the idle position. You will call out and simulate the necessary procedures as directed by your IP. Minimum single-engine airspeed is 100 knots with gear down and wing flaps extended 50 percent or less. However, maintain 110 knots on final approach to provide better controllability and allow for more airspeed in case a go-around becomes necessary.

6.6.1. Simulated Single-Engine Pattern and Landing:

6.6.1.1. Execute the break and retard the throttle to slow the aircraft. Continue a level turn to the downwind leg. The speed brake is not normally used; but if it is extended, the thrust attenuators would remain out throughout the pattern. Using the speed brake in a single-engine situation adds drag at a time when thrust is critical. However, use the speed brake as required to control airspeed.

6.6.1.2. Roll out on the downwind leg, and establish a drift correction if necessary. With airspeed below 150 knots, place the landing gear handle down. Continue to maintain altitude and make all gear down checks. Use power as necessary to maintain altitude and a minimum of 120 knots on downwind until the final turn is initiated. Rudder pressure may be necessary to maintain coordinated flight due to unequal thrust. The downwind leg is slightly wider than in the normal pattern to allow for the increased glide ratio resulting from half flaps and the absence of the speed brake in the final turn. After the gear is down and checked, place the wing flap handle to 50 percent at an airspeed of 135 knots or less before initiating the final turn.

6.6.1.3. Complete the final turn as you would for a standard overhead pattern. As you begin the final turn, adjust the throttle as necessary and set the pitch attitude and bank angle. The airspeed will gradually decrease to 110 knots as the final turn progresses. Maintain 110 knots in the final turn and on final approach. It is important to maintain the proper pitch attitude to reach the desired final glide path.

6.6.1.4. As you roll out on final approach, adjust the pitch attitude to place the runway threshold in the middle of the windscreen (as you did on the normal final approach) and add rudder to maintain runway alignment. With a low power setting and only one engine, you must anticipate the need for power and lead your throttle inputs to maintain desired airspeeds. Plan to maintain a minimum of 50 percent rpm on final.

6.6.1.5. During an actual single-engine recovery, power required on the good engine throughout the final turn and approach may be higher than in a simulated single-engine landing.

★6.6.1.6. Use half flaps for single engine patterns and landings. You may use the speed brake on final approach after the landing is ensured. Also, you may use full flaps after landing is ensured to prevent landing long. Remember, as power is reduced for landing, the rudder pressure used to maintain runway alignment must normally be decreased. Changes in rudder pressure can occur quite rapidly if you reduce power abruptly.

6.6.1.7. Plan the simulated single-engine touchdown in the first 1,000 feet as in the normal pattern. The emphasis, however, is on the proper touchdown attitude rather than a fast landing in the first 1,000 feet. A touchdown on speed (proper touchdown attitude) within the first 1,500 feet of the runway is acceptable under normal circumstances.

6.6.1.8. Touch-and-go landings are authorized from simulated single-engine approaches if power is applied to both engines after touchdown.

6.6.2. Single-Engine Go-Around. Although this maneuver will not be practiced, your IP will discuss the correct technique. The importance of an early decision cannot be overemphasized because of the greatly reduced performance with only one engine available. During a go-around initiated below 300 feet above the terrain, it is probable that the aircraft will contact the runway regardless of your intentions. It is imperative you retract the speed brake immediately (in accordance with boldface procedures) upon deciding to go around. You must use the rudder to maintain coordinated flight during the go-around. Additionally, slowing to 100 knots may reduce the descent rate allowing you to clean up the aircraft faster. Be careful and remember the minimum single engine airspeed is 100 knots. Your aim is to reduce drag which enhances your ability to reduce the descent rate and (or) accelerate.

6.7. No-Flap Pattern and Landing. The procedures for entry, initial approach, and the break are the same as in the normal overhead pattern, except you should call no flap on initial.

6.7.1. The downwind leg is longer and wider than in the normal pattern. When the airspeed reaches 150 knots or less, lower the gear and perform all gear down checks. Adjust the throttles as necessary to maintain a minimum of 120 knots until you start the final turn. Initiate the turn by adjusting

both throttles as necessary and setting the proper pitch attitude and bank angle. The horizon will be approximately in the middle of the windscreen. Airspeed will gradually decrease to 110 knots.

6.7.1.1. Plan the final turn to rollout on final with a good glide path. Rolling out on final, you will have to increase the pitch attitude slightly to place the runway threshold approximately in the lower one-third of the windscreen. The no-flap glide path is shallower than a normal glide path. It is approximately 3°, which equates to approximately 300 feet AGL at 1 mile from the approach end of the runway. The rollout on final can vary between ¾ to 1 mile from the runway. Adjust the altitude lost during the final turn to establish a good glide path. Also adjust the starting point for the final turn for wind. A longer final approach is necessary to compensate for reduced drag. Adjust power as necessary to maintain 110 knots during the final turn and on final approach. Plan to maintain a minimum of 50 percent rpm on final.

6.7.1.2. Do not set up a long nose-high, dragged-in approach. The most important thing is airspeed control. Remember, stall speed increases with no flaps and (or) high fuel weights.

6.7.2. Plan the final approach so you cross the end of the runway a few feet above the ground. Retard the throttles to idle when the landing is ensured. The aircraft will float longer and the landing attitude will be slightly more nose-high compared to a landing with flaps. Plan your no-flap touchdown in the first 1,500 feet of the runway with a proper touchdown attitude. Use caution as you round out and touch down during no-flap landings. If an excessive flare is used, you might land on the aircraft's tail skid or encounter a stall. This will occur if the aircraft's pitch is raised to a point where the glare shield reaches the horizon as you look over the nose of the aircraft.

6.8. Landing on Alternate Sides of the Runway. When landing on alternate sides, plan to land near the center of the runway. The side of the runway closest to your turn off the runway is known as the "cold" side; the side away from the turn off is the "hot" side. If traffic permits and the approach and landing for a touch and go or full stop will not affect spacing criteria, landing in the center of the runway is acceptable.

6.9. Go-Around. Sometimes during traffic pattern and landing practice, you will find yourself poorly positioned. In this case, discontinue your approach for reasons of safety and execute a go-around. Although you can abort an approach at any point,

a go-around is usually executed from the final approach or roundout. The sooner a poor landing condition is recognized and the go-around is started, the safer you will be. Do not wait until the last second to make a decision, and do not try to salvage a bad approach. Ideally, there should be little need for a runway supervisor to direct a go-around. The pilot of the aircraft should execute the go-around when a dangerous condition is encountered. Examples of dangerous conditions are low final turns, overshoot final turns, wake turbulence, distracted attention, and other aircraft too close.

★6.9.1. Final Approach or Landing Go-Around.

The correct method for executing a go-around from the final approach or landing phase is to simultaneously advance the throttles to military power and retract the speed brake. Depending on your airspeed, you may need to advance the throttles to a power setting less than military to prevent overspeeding the flaps and landing lights. When you are sure you will remain airborne and have reached 100 knots, retract the landing gear and (if applicable) turn off the landing lights. After ballooning or bouncing, a second touchdown may occur. Under these conditions, you might consider delaying gear retraction. Remember to call gear clear on dual sorties. When the gear handle is up and a minimum airspeed of 110 knots is attained, raise the flaps. As the flaps retract, raise the nose slightly to offset any tendency of the aircraft to sink. Clear the runway if necessary to avoid overtaking an aircraft ahead of you. (*Exception:* It is not necessary to clear the runway during a go-around if the runway is clear of other aircraft.) After attaining a safe altitude and airspeed, smoothly roll into a shallow banked, coordinated turn and turn approximately 20°. When you are well clear of the runway, execute another turn to realign yourself with the runway. The direction of these clearing turns will depend on local procedures at your base. Allow the aircraft to accelerate to 150 to 200 KIAS, and climb or descend to 500 feet above the terrain during the go-around until you are beyond the departure end of the runway or as directed locally.

6.9.2. Final Turn Go-Around. Normally the procedures for a go-around from the final turn are performed after rolling out on final approach. In the final turn, use power as necessary to maintain a safe airspeed. Monitor your airspeed closely to avoid overspeeding the gear and flaps. If a go-around to the inside of the normal pattern is required, use extreme caution. Attempts to tighten a turn without proper consideration for power and airspeed could lead to a stall. Never break out

from the final turn. Your IP will cover techniques for this type of go-around.

6.9.3. Straight Through on Initial. If it is necessary to discontinue a pattern before the break, continue straight through on initial at 1,000 feet above the ground and 200 knots or as directed locally. At the departure end of the runway or as directed locally, turn to crosswind. Clear below for aircraft on takeoff leg or pulling up into closed traffic and for aircraft already established on closed downwind.

6.9.4. Breakout From an Overhead Pattern. If it is necessary to discontinue an overhead pattern, follow the local procedures for leaving traffic. Do not wait to be directed to break out if you see a dangerous situation developing. Use your initiative and judgment and exit traffic immediately. If you are directed to leave traffic, follow instructions without hesitation. Use caution when breaking out from the downwind leg because you will have slow airspeed and may have the gear and (or) flaps extended.

6.10. Straight-In Approach. The straight-in approach is used when conditions require a landing with minimum maneuvering. Examples of these conditions are structural damage, an open nose-access door, or an unlocked canopy. Your IP will demonstrate the straight-in approach and have you practice it with and without flaps as follows:

6.10.1. Notify the runway supervisor or tower as directed locally, and obtain permission for the approach.

6.10.2. Arrive at the designated entry point at 500 feet above the terrain, if not otherwise specified.

6.10.3. Before you are 2 miles from the runway, lower the gear, lower flaps as desired, turn landing lights on, and establish approach airspeed.

6.10.4. During a normal straight-in, lower the speed brake and start the descent to establish a normal glide path. Continue as you would on a normal final approach.

6.10.5. During a no-flap straight-in, reduce power as necessary and start the descent to establish a no-flap glide path. Continue as you would on a no-flap final approach.

6.11. Crosswind and Gusty-Wind Landings. Winds in the pattern may require changes in airspeeds and configurations. These changes depend on wind speed, direction, and (or) gust. Use the flight-crew checklist or RSU's directions to determine the recommended flap settings (table 6.1).

TABLE 6.1

T-37 CONFIGURATIONS AND AIRSPEEDS (FINAL TURN/FINAL)

ITEM	A	B		C	
	Configuration	Gusty Winds		Flap Settings Due to Strong Crosswinds	
		Final Turn/Final	Flaps	50%	Zero
1	Normal	110/110	50%	110/110	120/120
2	Single engine	120/120			
3	No flap		0%		

6.11.1. If 50 percent flaps are recommended, use (1) two-engine patterns maintaining 110 KIAS in the final turn and on final, (2) single-engine patterns maintaining 110 KIAS in the final turn and on final, or (3) no-flap patterns maintaining 110 KIAS in the final turn and on final. If zero flaps are recommended, use (1) two-engine patterns maintaining 120 KIAS in the final turn and on final (lower the speed brake in the normal sequence; this is called a zero flap pattern), (2) single-engine patterns maintaining 120 KIAS in the final turn and on final, or (3) no-flap patterns maintaining 120 KIAS in the final turn and on final. For simplicity, just remember if 50-percent flaps are recommended due to crosswinds, fly 110 KIAS in the final turn and on final for all overhead patterns. For zero flaps, fly the final turn and final at 120 KIAS.

6.11.2. Occasionally, you will encounter gusty winds that may not require a higher than normal nose-wheel lift-off. Use: (1) two-engine patterns with 50 percent flaps and 110 KIAS in the final turn and on final, (2) single-engine patterns with 50 percent flaps and 120 KIAS in the final turn and on final, or (3) no-flap patterns maintaining 120 KIAS in the final turn and on final. Because of the possibility of a sudden loss of lift from changing wind conditions, do not attempt to fully flare the aircraft.

6.11.3. Plan the final turn to roll out on final between $\frac{1}{2}$ to $\frac{3}{4}$ mile, using half or full flaps. Under no-flap or zero-flap conditions, plan to roll out on final between $\frac{3}{4}$ to 1 mile. Establish crosswind controls on final to maintain runway alignment. Maintain airspeed by readjusting the power to compensate for the increased drag caused by the effects of cross controls. Continue to use these controls through the flare and touchdown.

6.11.4. Touch down in a nose-high attitude, and smoothly lower the nose to the runway above the

computed nose-wheel touchdown airspeed. Maintain aileron deflection into the wind throughout the landing roll. Larger control deflections are required as airspeed decreases.

6.11.5. Initially, maintain directional control with rudder and (or) brakes. Nose wheel steering is not normally necessary until the aircraft has slowed to normal taxi speed. When you engage the nose wheel steering, center the rudder pedals before depressing the nose-wheel steering button. At high airspeeds, nose wheel steering is extremely sensitive and easily overcontrolled. Before reaching taxi speed, use nose wheel steering only if you are unable to maintain directional control with the rudder and brakes on the landing roll.

6.12. Closed Traffic. The closed traffic pattern was devised to get the aircraft on the ground, using a minimum amount of fuel. You may accomplish a closed traffic pattern from an initial takeoff, touch-and-go landing, or go-around.

6.12.1. At a minimum of 150 knots and no sooner than the locally designated point, request clearance for a closed traffic pattern. Do not initiate the pattern with a straight-in reported between 5 and 2 miles unless cleared by the controller.

6.12.2. When you have received clearance, clear the area and start a climbing turn to the downwind leg. Plan your pullup, using approximately 60° of bank, so the downwind leg is displaced at approximately the same distance from the runway it would be after a break. Minimum airspeed during the pullup is 150 knots; maximum bank in the pullup is 90° .

6.12.3. When you roll out on the downwind leg, make a call to the RSU or tower. If you plan a full stop landing, state your fuel remaining. Indicate you are flying a no-flap pattern or a practice zero-flap pattern, if applicable. Clear and

continue with normal approach and landing procedures. (Lower speed brake, gear, and flaps at the same points as in a normal pattern.) If the controller instructs you to break out, follow the local procedures for leaving traffic from an inside downwind.

6.13. Low Closed Traffic. This pattern was devised to allow practice circling approaches in the local traffic pattern. The prerequisites for requesting a low closed traffic pattern are the same as for a normal closed traffic. Radio procedures are the same except you add the word "low" to your request. Perform low closed patterns only between official sunrise and sunset.

6.13.1. Plan the pullup to attain the desired lateral downwind position at approximately 500 feet AGL. Use normal closed traffic procedures during the pullup and on downwind. Since the downwind altitude is lower, the power and pitch requirements are different.

6.13.2. Lower gear and half flaps on downwind, and maintain 110 knots while circling to land. (Landing lights are optional.) Extend additional flaps and speed brake on base or final, as desired, using normal circling procedures. With crosswind or gusty wind conditions, configure by using flap settings and airspeeds used on final during contact conditions.

6.14. Final Turn Radio Call. This call is an important part of the traffic pattern procedure. It tells the controller where you are. Transmit the gear-down call as soon as safely possible after starting the final turn. Add single-engine, no flap, zero flap, and (or) full stop, if applicable. No response from the controller means you are cleared to continue with the requested approach, but be alert for other instructions from the RSU or tower. Regardless of the type of approach flown (overhead, straight-in, precision, or nonprecision), DO NOT make a gear-down call until the gear is DOWN AND LOCKED.

6.15. Landing Irregularities. Up to this point, explanations of landings have been devoted mainly to ideal situations in which landings were executed correctly. However, there are several errors student pilots might make while developing landing proficiency so you must be thoroughly familiar with the causes, effects, and proper recoveries from these situations.

6.15.1. Low Final Approach. There are different ways to get below the desired flightpath. You can start the final turn too late, place the final turn

too far from the runway while maintaining normal pitch and descent rates, or dive the aircraft through the final turn. The result is excessive altitude loss and a final approach below the desired approach path. Such a situation requires additional power to fly the aircraft to the runway. This is called a dragged-in final approach and should be avoided.

6.15.1.1. A dragged-in final approach is dangerous because you may misjudge the extra power needed to fly in this attitude. Once you have become accustomed to the amount of power normally required on final, habit may cause you to use only this amount. With inadequate power in this nose-high, level-flight condition, the aircraft may stall. Dragging the aircraft in with a dangerously nose-high attitude is not the proper solution for the error in judgment that was made in the final turn.

6.15.1.2. Adjust pitch and power as soon as you start getting low on final approach; then readjust pitch and power when you are back on the proper glide slope. If you have any doubt about the approach (that is, if it looks wrong or feels wrong), go around.

6.15.2. Steep Final Approach. This approach is caused by placing the final turn too close to the runway, starting the final turn too early, or keeping the nose too high in the final turn. If the final approach is continued, a high descent rate with a low power setting will result. This low power setting, coupled with the pitch change required to intercept the normal glide path, results in a rapid decrease in airspeed and a high sink rate. If you do not correct early or go around, this power deficient situation could result in a very firm touchdown or a stall.

6.15.3. Too Slow on Approach. When you fly too slow on the final approach, your perception of the proper glide path and roundout height may be inaccurate. The point to begin the roundout is lower with low airspeed and requires more precise judgment. Also, the aircraft may stall, depending on the pitch attitude, flap setting, and (or) control inputs, especially if the wind is gusty. When you are slow on final, you have much less margin for error. When you recognize a slow approach, make the same recovery as for a low final approach. Apply power at an altitude high enough to reestablish the correct airspeed and attitude or go around.

6.15.4. Rounding Out Too High. Sometimes when the ground stops moving toward you, your roundout has been too rapid and you are too high above the runway. To compensate for this, maintain a constant pitch attitude by releasing a

slight amount of back pressure until the airspeed diminishes slightly and the aircraft again starts descending. Then continue the roundout.

6.15.4.1. Use this technique only when you have adequate airspeed and runway. If you have reached a landing attitude and are still well above the ground, don't wait for the aircraft to start descending again. Go around and plan another approach. Remember, when the landing attitude is attained, the aircraft is rapidly approaching a stall. As the airspeed decreases, you are approaching the critical AOA.

6.15.4.2. You have learned that as the nose is lowered to a descending attitude, the pitch change causes lift to decrease momentarily. This is also true during a roundout. Do not lower the nose to increase the rate of descent when you are fairly close to the runway. The momentary decrease in lift may cause the aircraft to land on the nose wheel, which could collapse. You should go around any time that you feel the need to lower the nose excessively to avoid a stall during the roundout. The need for substantial lowering of the nose is an indication you are too high above the ground and approaching a stall.

6.15.4.3. Any time you approach a stalling condition after ballooning or bouncing, apply full power, adjust your pitch attitude, and go around. It is unsafe to continue the landing. However, if you have applied power to go around and the aircraft continues to settle, do not try to hold it off by raising the nose above the landing attitude. Hold the landing attitude, and let the aircraft touch down if it wants to. The contact will be moderate if you have added power, and you will be safely airborne again shortly.

6.15.5. Rounding Out Too Late or Too Rapidly. If you are late in starting the roundout and pull the stick back too rapidly in an effort to prevent a touchdown, you can cause an accelerated stall. This is a dangerous situation which may cause an extremely hard landing on the main gear. This may or may not be a controllable situation, depending on the airspeed. If it occurs, immediate use of power will increase thrust, lift, and controllability and will enable you to recover and go around. The important things to remember in this situation are: (1) don't panic, (2) recognize the problem, and (3) do something immediately—that is, add power and control the aircraft. In your recovery, hold the landing attitude. Your main gear will probably contact the ground a second time; but if you have initiated recovery properly, your second contact is normally moderate.

6.15.6. Porpoising. This is a condition encountered during landing, where the aircraft bounces back and forth between the nose wheel and main gear. It is caused by a landing attitude at touchdown which brings the nose wheel in contact with the runway before the main gear touchdown. It most likely will occur when landing is attempted with an incorrect landing attitude and at an excessive airspeed. If immediate corrective action is not initiated, the porpoise will progress to a violent, unstable pitch oscillation. Because repeated heavy impacts of the aircraft on the runway will ultimately result in structural damage to the landing gear and airframe, a proper landing attitude immediately before touchdown is imperative to prevent the occurrence of a porpoise.

6.15.6.1. If you begin to porpoise, immediately position the controls to establish a nose-high attitude sufficient to prevent the nose wheel from contacting the runway. Maintain this attitude, and simultaneously advance the throttles to military. Do not attempt to counteract each bounce with opposite stick movement. The combined reaction time of pilot and aircraft is such that this control movement will aggravate the porpoising action. Repositioning and holding the controls (restricting movement) will dampen out the oscillation. The addition of power will increase control effectiveness by increasing airspeed. It will also allow the aircraft to become safely airborne.

6.15.6.2. If a go-around is initiated after porpoising, do not raise the landing gear. Structural damage can occur during porpoising, which may prevent the landing gear from being lowered on the following landing attempt.

6.15.6.3. If porpoising occurs during an actual single-engine landing, do not increase power on the good engine. The unequal thrust will make directional control difficult. Position and hold the controls to establish a normal landing attitude. Do not attempt to counteract each bounce with opposite stick movement.

6.15.7. Floating. When you misjudge the final approach (for example, reduce the power too late, use too much power on final, or fail to use the flaps properly), your tendency is to dive toward the end of the runway in an attempt to land. When you dive, the airspeed increases. This causes you to float and possibly balloon or bounce, and you will be well down the runway before landing. To correct a slight problem of floating, gradually adjust (increase) the pitch attitude as airspeed drops and landing speed is approached. The recovery from floating will depend on the amount of floating and runway remaining. Avoid pro-

longed floating, especially in strong crosswinds. If you have any doubt about the recovery, execute a go-around.

6.15.8. Ballooning. There are several factors that cause an aircraft to balloon. Rounding out too rapidly or raising the nose to the landing attitude before lift has decreased sufficiently will cause you to balloon (figure 6.5). The altitude gained will depend on the airspeed or the rate at which the pitch attitude is increased.

6.15.8.1. When ballooning is slight, you may complete the landing. Maintain direction, hold a constant landing attitude, and let the aircraft settle onto the runway. Use rudder pressure to keep the aircraft straight as it settles onto the runway. When ballooning is pronounced, go around. Do not attempt to salvage the landing.

6.15.8.2. Be extremely cautious of ballooning in crosswinds. If you do not maintain the wing-low crosswind correction until touchdown, the aircraft will probably balloon more because of the added lift as you level the wings. This puts you in double jeopardy because you will start drifting once you level the wings. Be sure to keep the appropriate wing down in a crosswind and maintain direction with opposite rudder. If you balloon slightly, you may need to lower the wing even further to compensate for the relative increase of drift component at the lower airspeed. Again, if you have any doubt, go around.

6.15.9. Bouncing. Bouncing is very similar to ballooning. What is different is the cause. If the aircraft strikes the runway hard, it will bounce into the air. The height it reaches depends on the force with which it strikes the runway and the amount of back pressure held. This height also depends on the speed at the point of touchdown. The aircraft may bounce if it makes contact with the ground before the landing attitude is attained. A common student error is to apply excessive back

pressure when the student realizes too late that the aircraft is settling too fast, but he or she is not yet in the landing attitude. In attempting to correct the first mistake, the student increases pitch attitude too late—just as the bounce occurs. Both factors tend to force the aircraft aloft again.

6.15.9.1. The corrective action for a bounce is the same as ballooning, and it depends on the severity of the bounce. When the bounce is slight and there is no great change in pitch attitude, continue with the landing. Maintain direction and smoothly adjust the pitch to the landing attitude just before touchdown. When a bounce is severe (that is, you feel the aircraft rising rapidly), go around immediately. Simultaneously apply power, maintain direction, and lower the nose to a safe pitch attitude. Follow through with the go-around even if another bounce occurs. Do not attempt a landing from a bad bounce.

6.15.9.2. Since airspeed diminishes very rapidly as the aircraft rises, a stall may occur before a landing is made. Expect to contact the ground or bounce a second time during a proper recovery. The second bounce will not be as severe.

6.15.9.3. Use extreme caution any time you bounce in a crosswind. When one wheel strikes the runway, the other wheel will touch down immediately afterwards. The crosswind correction is lost, and the aircraft will drift. You should reestablish crosswind controls to stop the drift and either continue the landing or go-around depending on your situation.

6.15.10. Landing in a Drift or Crab. At times you may find yourself correcting for drift by crabbing on the final approach. If you round out and touch down while the aircraft is drifting or in a crab, it will contact the runway moving sideways. This will impose extreme side loads on the landing gear and may cause material failure.

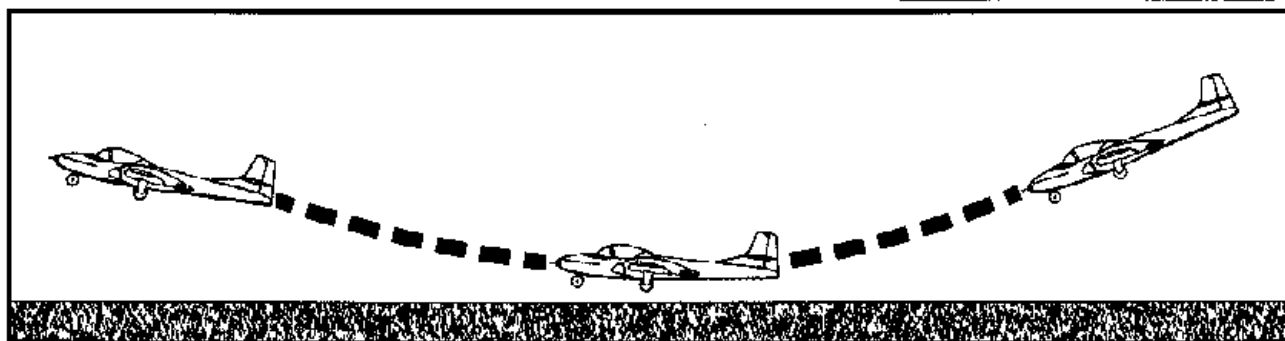


Figure 6.5. Ballooning Results From a Too-Rapid Roundout.

6.15.10.1. After crabbing into the wind, the proper method of correcting for drift on the final approach is the wing-low method. This allows you to keep the longitudinal axis aligned with the runway throughout the final approach and landing.

6.15.10.2. During final approach, roundout, and touchdown in a crosswind, the path or track of the aircraft over the ground is a straight line in the same direction as the runway, and the fuselage of the aircraft should remain lined up with the runway throughout. In other words, you should not angle toward the runway or cock the nose. Failure to apply sufficient wing-low crosswind corrections will result in landing with a drift, in a crab, or a combination of both.

6.15.11. Wing Rising After Touchdown. During crosswind landings, a wing may rise during the landing roll. Depending on the amount of crosswind and degree of corrective action, you could lose directional control.

6.15.11.1. When an aircraft is rolling along the ground in a crosswind, the upwind wing is receiving greater impact of air pressure than the downwind wing because the fuselage blocks the wind over the downwind wing. This causes a lift differential. The wind also strikes the fuselage on the upwind side. This causes a rolling moment about the

downwind main landing gear, which may further assist the raising of the upwind wing. When the effects of these two factors are great enough, one wing may rise even though directional control is maintained. If no correction is applied, one wing will rise enough to cause the other one to strike the ground. Use rudder, brakes, and (or) nose-wheel steering to maintain directional control; use ailerons to keep the wings level. If a wing starts to rise during the landing roll, immediately apply more aileron toward the high wing and continue to maintain direction. The sooner aileron is applied, the more effective it is. The further you allow a wing to rise before taking any corrective action, the more aircraft surface is exposed to the impact pressure of the crosswind.

6.15.11.2. There is a situation where a wing comes up and there is also a loss of directional control. Not only are the same factors attempting to raise the wing, but the crosswind is also acting on the fuselage surface behind the main wheels and is swerving the aircraft into the wind. Again, you should apply aileron to lower the high wing and stop the swerve with the most effective control. When the wings are approximately level, maintain directional control until the aircraft has slowed to taxi speed or has stopped.

Chapter 7

NIGHT FLYING

7.1. Introduction:

7.1.1. Night flying is a very important phase of pilot training. Do you remember how surprisingly easy it was to learn to drive an automobile at night? The transition from day to night flying is just as easy. You will find that most of the same techniques and procedures used in day flying will apply at night. Generally speaking, any apprehension you might have about night flying will result from restrictions placed on your visibility. Once you overcome the feeling of discomfort because of visual limitations, you should have very little difficulty in flying at night.

7.1.2. Before night flying you should be familiar with the location and positions of all switches and controls. The ability to locate switches and controls should become second nature to you through practice in either a synthetic trainer, simulator, or parked aircraft. Determine which switches might be mistakenly or accidentally actuated and whether or not such a mistake could create a problem. If so, spend extra time learning the correct switches in this area.

7.1.3. The traffic pattern during night flying is the same as the day pattern, but some of the visual checks and procedures used in daytime are more difficult at night. Orientation with the ground and other aircraft is harder to maintain. Tension is quite normal because flying an aircraft at night is a new and different sensation. For example, you may notice lights reflecting on your canopy due to glare from your instrument or cockpit lights. Do not confuse these with lights of other aircraft. Once you realize the things that appear strange at night are really quite normal, you will have overcome your biggest obstacle to successful night flying.

7.1.4. Night flying will demand more of you than day flying. You must be constantly alert for other aircraft in the area. You may have to rely on your instruments to determine the attitude of the aircraft. Know your cockpit procedures for taxiing as well as for flying. This will eliminate confusion and the need for turning up the cockpit lights unnecessarily.

7.2. Spatial Disorientation. A pilot is much more susceptible to spatial disorientation at night than during the day. Also, depth perception at night is not completely reliable.

7.2.1. Before takeoff, always study a map of the field. Get a good mental picture of the takeoff runway and taxiways leading to it. Too often pilots on a strange field at night take wrong turns, thus losing time and creating confusion.

7.2.2. Always carry an operable flashlight. If there is electrical failure, a flashlight is your only means of checking the instruments or maps.

7.2.3. The T-37 lighting system consists of red and white lights for the cockpit and instrument panel. These lights are used on the instrument panel separately or in combination, and they can be adjusted for intensity. Adjust instrument lights to the minimum necessary to read the instruments. This will avoid eye strain and keep canopy reflections to a minimum. Remember, once your eyes are adapted to the dark, even a momentary glance at bright lights destroys their adaptation. With bright instrument lights you are unable to distinguish objects outside the cockpit until your eyes readjust.

7.3. Inspections and Checks. In addition to the normal daytime exterior check, perform the following:

7.3.1. Ensure all required exterior and interior lights are operational (AFR 60-16).

7.3.2. Ensure all transparencies are clean. Scratches and dirt cause reflection. Ask the ground crew to wipe off any spots on the windshield and instrument panel.

7.3.3. Keep the cockpit lights turned down to a comfortable level, including those controlled by the warning light's dimming switch. This is especially important during traffic pattern operation because canopy glare and bright lights can seriously restrict visibility when clearing is most important.

7.3.4. Know the location of all important switches by touch to avoid operating the wrong one in a dim or dark cockpit. The same applies to all control levers. The flap lever and landing lights are items required at a critical time in the landing pattern. Know their locations by touch. Also know the location of the flap indication without searching for it.

7.3.5. Store your flashlight in a readily accessible place.

7.4. Taxiing. Judgment of speed and depth is poorer at night. Allow for this, and follow procedures with extra care. Always taxi more slowly at night to compensate for the reduced visibility. Although the taxi light is normally used for night taxiing, use the landing lights when necessary. The anticollision beacon may also be used to increase your visibility to other aircraft while taxiing. Taxi on established taxi lines. If you are taxiing toward a landing runway, use caution with your taxi lights. Do not blind the pilots of landing aircraft.

7.5. Takeoff. Line up on the center line of the runway, and perform a static takeoff. Before brake release, turn on taxi or landing lights and complete the lineup checklist. After brake release, look down the runway—not to one side—at the runway lights. On night takeoffs, there is a tendency to fly the aircraft back onto the runway so do not retract the gear in a hurry. Be sure to confirm gear clear. If you become disoriented, resort immediately to instrument flight. Use the instrument takeoff procedures. If you resume outside visual reference, use extreme caution because of deception and broken continuity in unlighted areas. You needn't be alarmed by loss of references on takeoff if you go confidently on instruments, maintaining a positive pitch attitude on the attitude indicator and a positive rate of climb on the VVI.

7.6. Area Orientation. Your IP will show you the local flying area, prominent landmarks, familiar cities or towns, and any points of interest that may help to keep you oriented. Your IP will also point out local hazards at night and minimum safe altitudes for local night operations.

7.6.1. There are several methods to compensate for the lack of visual references at night. Two of these methods are using a reduced descent rate

and reading out altitudes over the intercom when descending for a level off close to the ground.

7.6.2. Use extra care in reading the altimeter at night because your actual height above the ground is difficult to visually confirm. Many accidents have resulted from pilots who have misinterpreted altimeter readings; constantly guard against this error. Careful interpretation of altimeter indications is an absolute necessity for safe night flying.

7.6.3. After you are comfortably adjusted to night flying, your IP will place the aircraft in an unusual attitude. You will then recover from the unusual attitude and return the aircraft to level flight using instruments only. Should you become disoriented, you must trust your instruments. Causes and hazards of spatial disorientation are listed in AFM 51-37, and they must be clearly understood by all aircrews before night flying.

7.7. Landings. The importance of using the before-landing checklist on night landings and of making sure the gear is down and locked before turning onto final cannot be overstressed. After rolling wings level on final, concentrate on the descent and plan to touch down within the first 1,000 feet of the runway. Keep your eyes moving; don't stare at any bright lights on the ground. It is easy to confuse a moving light with a stationary one. Plan to touch down on the center line of the runway. Turn on the landing lights after rolling out on final. On touch-and-go landings, turn off the landing lights after retracting the gear and before retracting the flaps. The landing lights do not turn off until they are fully retracted. The movement of the light beam as it drops away from view may cause a climbing sensation. Therefore, after turning off the landing light switch, monitor your instruments closely. When flying in the traffic pattern or other congested areas, be especially vigilant for other aircraft. Constantly look around for aircraft lights.

Chapter 8

FORMATION

Section A—General

8.1. Introduction:

8.1.1. The basic premise of formation flying is the concept of mutual protection; the days of going it alone are buried in history. The team concept is essential to successfully engage and defeat the enemy in today's high speed air warfare. Each member of the team has something to contribute if the team is to perform its function of destroying enemy personnel and resources. Mutual, not independent, action is the secret of successful air warfare. Although bomber, troop carrier, and interceptor missions require limited precision formation, most fighter aircraft flying is done in formation. A fighter formation must be flexible enough to meet the most significant or immediate threat, yet still complete the mission. The selection of a particular formation is determined by the mission, performance of your aircraft compared to the enemy aircraft, air superiority situation, and enemy tactics. Regardless of the formation used, each has one thing in common—a dependence on all members of the flight. Teamwork is the vital key to success.

★8.1.2. The effectiveness of a formation mission is highly dependent on solid flight discipline. This originates in mission preparation and is displayed in the formation briefing by flight lead or another designated flight member. During the briefing, the flight lead formally describes the mission and establishes the rules of conduct for all flight members during ground operations and inflight maneuvers. Flight discipline is displayed when each flight member adheres to these rules of conduct throughout the mission until debriefing. Uncompromising flight discipline is absolutely essential for successful mission execution.

8.1.3. More than any other type of flying, formation builds confidence and teaches self-reliance, self-discipline, and proper application of aggressiveness in military flying. Aggressiveness is a state of mind, an attitude not to be confused with speed of flight control movement or reckless abandon. Aggressiveness is knowing the rules and parameters, recognizing deviations, and making expeditious, controlled corrections. T-37 formation training teaches you the basic techniques and procedures. You will learn lead's duties and responsibilities, but the wing position receives the greatest emphasis. You must be disciplined and aggressive, and you must trust lead. The ability to fly good formation does not come easily.

8.2. Responsibilities:

8.2.1. **Collision Avoidance.** All formation members must be conscious of the potential for a midair collision associated with formation flying. This manual cannot possibly address every situation that, if mishandled, could result in an accident or incident. The procedures in this manual are designed to accomplish course objectives and maximize safety, but nothing prevents an aircrew-member from taking whatever action is necessary to avoid a collision. The ultimate responsibility for safe flight rests with each pilot. Several factors contribute significantly to the potential for a midair collision:

8.2.1.1. Failure of lead to properly clear or visually monitor the wingman during a critical phase of flight, such as during a rejoin or trail. As lead, you must monitor your wingman. Look at the wingman directly or use the mirror. Be prepared to offer assistance or take evasive action if your wingman loses sight of you. Do not hesitate to give instructions on what action should be taken because you are normally in a better position to know what these actions should be.

8.2.1.2. Failure to keep lead in sight at all times. As the wingman, you are most likely to lose sight of lead during pitchouts, rejoins, trail, or in IMC. While flying in IMC, if you cannot maintain the normal fingertip position using normal visual references or you lose sight of lead, immediately follow the lost wingman procedures (paragraph 8.7).

8.2.1.3. Failure to recognize excessive overtake. You must learn to judge closure and detect overshoots. The airspeed indicator can be a vital aid. During rejoins, compare your airspeed with the prebriefed or announced airspeed. If you are directly in trail, move laterally to gain greater perspective of closure rate and provide a safe margin for breakout or overshoot. Use power and (or) speed brake as necessary.

8.2.1.4. Failure to maintain lateral or vertical separation. This generally applies to turning or straight-ahead rejoins. Always maintain lateral or vertical separation until closure rates are under control and you reach the route position.

8.2.1.5. Failure to maneuver in the safest direction when visual contact is lost. As the wingman, if you lose sight of lead for any reason, break out of formation. Do not delay your breakout attempting to regain visual contact. Break in a safe direction (away from the last known position or

flight path of lead) to gain immediate separation. Call your breakout over the radio. Do not attempt to rejoin until you receive permission from lead.

8.2.1.6. Failure to consider the effects of wingtip vortices. Airplanes always produce vortices. Wingman usually fly into them when they get too close during fingertip maneuvers or crossunders. The resulting control difficulties are very dangerous. If you get into vortices, control your aircraft and move back out. Break out if you need to.

8.2.2. Lead. Clearing and planning are the most important aspects of leading a formation. You must monitor the wingman, clear the area, and plan each maneuver. Execute each maneuver with skill and precision, allowing the wingman to maintain position without difficulty. Never become so overly conscious of smoothness that precision or safety are compromised. It is far more important to fly your aircraft safely with minor excursions from perfect performance than to fly super smooth and be a liability to the flight. Plan all maneuvers to keep the flight well within the assigned working area. Select a power setting that will allow you to maneuver throughout the allowable air speed and altitude range. However, if this power setting proves unrealistic, do not hesitate to change it. High performance and high G maneuvers require smooth and deliberate control inputs to keep your wingman from exceeding G limitations while attempting to maintain formation position. You must also monitor the wingman to ensure he or she is in position before the next maneuver.

8.2.3. Wingman. The three basic aspects of being a wingman are maintaining position, mutual support, and formation integrity. Initially, you will spend most of your time learning to maintain position, but you should develop the other skills that are an integral part of being a formation wingman. Although your primary attention is devoted to maintaining proper position, you also can help clear for the formation. While referencing lead, you can clear the area you can see beyond the leader. Do this by using all of lead's aircraft as a reference; do not focus on just one spot. If you need to tell lead about a conflict, give call sign, traffic's clock position (prefaced with side), elevation (low, level, or high), and an approximate distance. For example, transmit "Curly, traffic right 2 o'clock, slightly high, 3. miles." Although procedural differences exist between operational units and from aircraft to aircraft, the following are basic wingman responsibilities:

8.2.3.1. Keep lead in sight at all times.

8.2.3.2. Be aware of the departure, recovery, and en route altitudes and routing so you can assume the lead at any time.

8.2.3.3. Monitor lead for system malfunctions and proper configurations. Assist when you can during emergencies.

8.2.3.4. Monitor the radios, and assist lead if necessary.

8.2.3.5. Maintain a constant awareness of the potential for a midair collision.

8.2.3.6. Trust lead and follow directions.

★8.3. Radio Procedures. Radio discipline is essential for effective formation operations and it is lead's responsibility to brief how radio operations will be performed. Aircrews should attempt to minimize radio calls to reduce frequency congestion. Lead must ensure calls are clear and concise, combining calls when practical. Unless briefed otherwise, wingman will acknowledge lead's verbal directions with an appropriate radio call.

★8.3.1. Radio procedures should be addressed in the formation briefing. Unless briefed otherwise, the wingman should change radio channels only when directed by lead and only after all flight members have acknowledged. Radio channel changes may be accomplished during any maneuver. When desiring to accomplish radio channel changes in fingertip, flight lead will thoroughly brief the procedures and ensure the wingmen understand their first priority is maintaining aircraft separation while changing channels. When desiring to accomplish radio channel changes in route, lead will normally direct the wingman to route. The wingman should change channels after assuming a two- to four-ship-width route position. Unless briefed otherwise, remain in route position until directed by lead. If in IMC, maintain fingertip spacing and use crew concept to accomplish channel changes (one crewmember flies the aircraft while the other accomplishes the channel change).

8.3.2. Aircrews of each aircraft in the formation will be assigned a call sign. For example, Captain X and his student sign out as Reno 01, and Captain Y and her student sign out as Reno 02. No two airborne formations will have the same word call sign (for example "Reno," "Vega," "Cheeta," etc.). Regardless of flight lead's position during takeoff, he or she will always use the call sign with the lowest numeric designator. In this case, flight lead would be Reno 01. Flight lead may use 11, 21, 31, etc., depending on the local wing's call sign procedures. In a four-ship formation, the deputy lead will always use the numeric call sign ending with the number 3. The flight lead will lead the entire mission and is responsible for the safe and efficient accomplishment of the mission objectives. However, flight lead may be in any position on takeoff, landings, and area work to optimize

training. The call signs received when the formation signed out will be used any time the formation breaks up. In the above example, when in formation Captain Y will acknowledge radio calls with her position number, but will use Reno 02 if the formation breaks up with no intention of getting back together. For radio calls within the formation, only the word call sign will be used as follows: Lead, "Reno, ops check;" Wingman, "2."

8.3.3. When a member of the formation has radio failure, the aircraft with the inoperative radio (no radio (NORDO)) normally assumes or retains the wing position. The flight member with the operative radio leads the NORDO aircraft into the pattern, notifies the RSU or tower, and makes a low approach to the landing runway. The NORDO aircraft flies the pattern and lands. Prebrief a straight-in approach or overhead pattern as appropriate for weather or pattern conditions.

8.3.3.1. Close formation (fingertip or route). Flight members who experience total radio failure while in close formation should maneuver within route parameters and attract the attention of another flight member. Give the appropriate visual signals. The mission should be terminated as soon as practical and the NORDO aircraft led to the base of intended landing.

★8.3.3.2. Other than close formation. If flying other than close formation when radio failure occurs and a planned rejoin will not shortly follow, the NORDO aircraft should cautiously attempt to rejoin to a route position on another flight member and rock its wings (attention in the air), but not complete the rejoin until receiving a rejoin signal. The NORDO aircraft is responsible for maintaining clearance from other flight members until his or her presence is acknowledged by a wing rock. Once joined, the NORDO aircraft will give the appropriate visual signals. The mission should be terminated as soon as practical and the NORDO aircraft led to the base of intended landing.

★8.4. Visual Signals. Except for in-flight checks, visual signals are used during formation flying to keep radio transmissions to a minimum. All visual signals are contained in AFI 11-205, and its AETC Sup 1 (formerly AFR 60-15/AETC Sup 1). Any nonstandard visual signals will be briefed before they are used. You must become completely familiar with these signals before flying formation. As the wingman, when lead gives a signal, acknowledge it by nodding your head. If you do not understand or are unsure of a signal, do not acknowledge. Lead will repeat the signal until an acknowledgment is received from you. Once again, do not hesitate to use radios to avoid confusion or when more practical.

8.5. In-Flight Checks:

★8.5.1. General. Weather permitting, make required checks in route formation unless briefed otherwise. Normally during scheduled checks, lead initiates the check by spreading the formation to route with either a radio call or visual signal. The wingman performs the appropriate check for the phase of flight. The wingman should accomplish the check one item at a time, checking his or her position on lead between each item. Unless briefed otherwise, return to fingertip formation only with flight lead's permission. During IMC, the crew concept will be used for completing in-flight checks. The pilot at the controls will fly the fingertip position while the other pilot performs the check. Lead should make normal turns, climbs, or descents during checks. If forced to turn during a check, lead should call the turn and ensure his or her wingman is attentive before turning. The wingman resumes the check after the turn is complete. Inflight checks are normally accomplished in the following manner:

★8.5.1.1. Lead. Spread the wingman to route with a radio call or visual signal. After directing the wingman to route, accomplish appropriate checklist items. Allow enough time for the wingman to do the same. Check the wingman in with a visual signal or by transmitting a call sign and total fuel ("Curly 1 is 1,200"). After the wingman checks in, return him or her to fingertip, leave in route, or direct to another position.

★8.5.1.2. Wingman. Acknowledge lead's visual signal or radio call, move to route, and perform the appropriate checklist items. Stay in route until lead directs otherwise. Check in with total fuel ("2 is 1,200") or a visual signal, as appropriate. While performing in-flight checks, continue to focus your attention on lead, using short glances to perform cockpit duties.

★8.5.2. Ops Check. This check is a check of the engine instruments, oxygen system, fuel quantity, and fuel balance. Perform this check periodically during every mission. When desiring an ops check, lead will use a briefed visual signal or transmit, "Curly, ops check." The wingman will acknowledge the visual signal or radio call, as appropriate. On completion of the check, lead should check the wingman in by relaying his or her total fuel. This can be done either visually or on the radio. The wingman should reply with total fuel. Lead should monitor any abnormal fuel state reported by the wingman.

8.5.3. Fuel Checks. Fuel checks are required in the ops and descent checks. At other times, lead will signal or call for a fuel check. Lead will monitor any abnormal fuel state reported by the wingman.

8.5.3.1. Joker fuel is the prebriefed fuel needed to terminate an event and proceed with the

remainder of the mission. An example is terminating area work and accomplishing a recovery for multiple patterns. The radio call is, "Curly 2 is joker." Lead will prioritize any remaining maneuvers and plan to recover no later than bingo fuel. Lead will acknowledge the wingman's joker call.

8.5.3.2. Bingo fuel is prebriefed fuel, which allows the aircraft to proceed to the base of intended landing using a planned recovery and landing with appropriate fuel reserves. Bingo fuel will not be overflown because it would preclude a safe recovery. The wingman will notify lead when reaching this fuel state by using the following radio call, "Curly 2 is bingo." Lead will acknowledge the wingman's bingo call.

Exercise.

CH-2 8.6. Speed Brake. Speed brake exercises are used to practice maintaining position when the speed brake is operated. The wingman lowers or raises the speed brake on a verbal or visual signal by lead. The wingman must anticipate a slight pitch change to avoid bobbing up and down.

8.7. Lost Wingman Procedures. Lost wingman procedures may not guarantee obstacle clearance. It is the responsibility of all the pilots in the formation to be aware of terrain and obstacles along their flightpath. Good judgment must be used when executing lost wingman procedures.

8.7.1. Actions. During actual weather conditions, the wingman may lose sight of the lead aircraft. The action taken depends on the phase of flight. The wingman should review pertinent procedures at each briefing where weather or other restrictions to visibility are known or anticipated for the flight.

8.7.1.1. In any lost wingman situation, immediate separation of aircraft is essential. On losing sight of lead or if unable to maintain position due to disorientation, the wingman will simultaneously execute the applicable lost wingman procedure while transitioning to instruments. Smooth application of control inputs is imperative to minimize the effects of spatial disorientation.

8.7.1.2. Additionally, the wingman will notify lead, who will coordinate with the controlling agency and request a separate clearance for the wingman. If required, the controlling agency can aid in ensuring positive separation.

8.7.1.3. Lead should immediately perform the appropriate procedure, acknowledge the lost wingman's radio call, and transmit lead's aircraft attitude, which will be acknowledged by the

wingman. Lead should transmit other parameters such as heading, altitude, and airspeed as necessary to aid in maintaining safe separation.

8.7.2. Two- or Three-Ship Flights:

8.7.2.1. Wings-level flight (climb, descent, or straight and level). Turn away, using 15° of bank for 15 seconds. Inform lead; then resume course and obtain a separate clearance.

8.7.2.2. Turns (climb, descent, or level). Outside the turn, reverse the direction of turn, using 15° of bank for 15 seconds, and inform lead. Roll out and continue straight ahead to ensure separation before resuming the turn. Obtain a separate clearance. Inside the turn, momentarily reduce power to ensure nose-tail separation and tell flight lead to roll out of the turn. Maintain angle of bank to ensure lateral separation, and obtain a separate clearance. Lead may resume turn only when separation is ensured. If in a three-ship flight with both aircraft on the same side of lead, refer to four-ship lost wingman procedures (paragraph 8.7.3).

8.7.2.3. Precision and nonprecision final approach. As the wingman, momentarily turn away from lead to ensure separation and start a climb to either the final approach fix or glide-slope intercept altitude, as appropriate. While proceeding to the missed approach point, inform lead and obtain a separate clearance from approach control. Either comply with the new clearance received or fly the published missed approach, as appropriate.

8.7.2.4. Missed approach. As wingman, momentarily turn away to ensure clearance; then inform lead and continue the published missed approach while climbing 500 feet above the missed approach altitude. Obtain a separate clearance from approach control.

8.7.3. Four-Ship Flights. (Numbers two and three will follow the procedures described in paragraph 8.7.2.) Because it is impossible for number four to immediately determine that number three still has visual contact with lead, it is imperative that number four's initial action be based on the assumption that number three has also become separated. If number four loses sight of number three, number four will proceed as follows:

8.7.3.1. Wings-level flight. Simultaneously inform lead and turn away, using 30° of bank for 30 seconds. Then resume course, and obtain separate clearance.

8.7.3.2. Turns (climb, descent, or level). On the outside of the turn, reverse the direction of the

turn, using 30° of bank for 30 seconds to ensure separation from lead and number three. Obtain a separate clearance. (Using 30° of bank for 30 seconds will develop a significant heading change from lead.) Maintain situational awareness for obstacle clearance as you separate from lead. On the inside of the turn, momentarily reduce power to ensure nose-tail separation and increase bank angle by 15°. Tell lead to roll out of the turn. Obtain a separate clearance. Lead will resume the turn only when separation is ensured.

8.8. Practice Lost Wingman Procedures. Lost wingman procedures will be practiced in VMC to prepare for actual situations you may encounter. Lead directs practice of lost wingman procedures with a radio call, "Curly, go practice lost wingman." At this time, the wingman executes the appropriate lost wingman procedures and acknowledges, "Curly 2 is practice lost wingman." The IP will monitor the lead aircraft to ensure adequate separation is maintained. After appropriate lost wingman procedures have been executed and permission for rejoin has been granted, lead will specify the type and direction of rejoin.

8.9. Spatial Disorientation in Formation. As lead of a formation, if you suspect your wingman is becoming spatially disoriented, transmit your current flight parameters. This may reduce or eliminate the sensations of spatial disorientation. As wingman, you must remain aware of flight conditions to the maximum extent practical. If you become spatially disoriented, inform lead and request flight parameters if necessary. Lead will minimize maneuvering, transmit flight information and, if in IMC, attempt to acquire VMC. If disorientation persists, lead should attain straight-and-level flight if possible and consider passing the lead to the wingman if conditions will allow lead to maintain orientation and situational awareness while on the wing. If conditions do not allow this, the wingman should make every effort to maintain formation position. If unable to maintain formation, the wingman immediately transitions to instruments while executing lost wingman procedures and notifies lead.

Section B—Two-Ship Formation

8.10. Engine Start, Taxi, and Takeoff:

8.10.1. If the aircraft are parked together, start engines on a visual signal; if they are parked separately, use a prebriefed starting time. If you are late arriving at the aircraft, do not omit items

on your preflight or rush engine starting procedures. Inform lead of any difficulties that may delay your departure.

8.10.2. After engine start, lead will check the flight in on the radio. Acknowledge with your formation position. After the flight checks in, lead calls for taxi clearance. The formation then taxis out, assuming proper position on pulling out of the parking area. If another aircrew attempts to taxi between you and lead, ask the pilot to hold. The formation should have the right-of-way. Taxi position for the wingman is two ship lengths behind lead when taxiing staggered. Increase the spacing to four ship lengths when taxiing directly behind lead.

8.10.3. Lead should taxi a sufficient distance down the runway to allow the wingman room to maneuver into position. The wingman lines up on the fingertip line with approximately 10 feet of lateral wingtip clearance. Lead considers such factors as wind, weather, and direction of the turn out of traffic when determining the proper side to place the wingman. Lead places the wingman on the upwind side for takeoff when the crosswind component exceeds 5 knots to keep him or her from entering your wake turbulence in the event he or she falls behind. If crosswinds are not a factor, put the wingman on the inside of the first turn out of traffic.

8.10.4. For takeoff in the wing position, lead looks at you and gives the runup signal. At this time, perform your lineup check and nod to lead when the check is complete. Lead will adjust throttles to 98 percent rpm to give you a power advantage. Lead will signal for brake release with the downward motion of his or her head. As the wingman, use power as necessary to maintain position on the takeoff roll. Use peripheral vision to help detect any lateral movement on the runway. Use nose-wheel steering to maintain directional control. Match lead's pitch attitude and stack level until the gear and flaps are raised.

8.10.5. When the formation is safely airborne with a minimum of 100 knots, lead retracts the gear. As the wingman, raise your gear when you see lead's gear begin to retract and you are sure you will remain airborne. If you are overrunning lead, you may delay retracting your gear; never raise your gear before lead. When the gear handle is up and the airspeed reaches 110 knots minimum, lead raises the flaps. The wingman raises his or her flaps at the same time and assumes the fingertip position (figure 8.1).

8.10.6. Lead maintains the takeoff attitude,

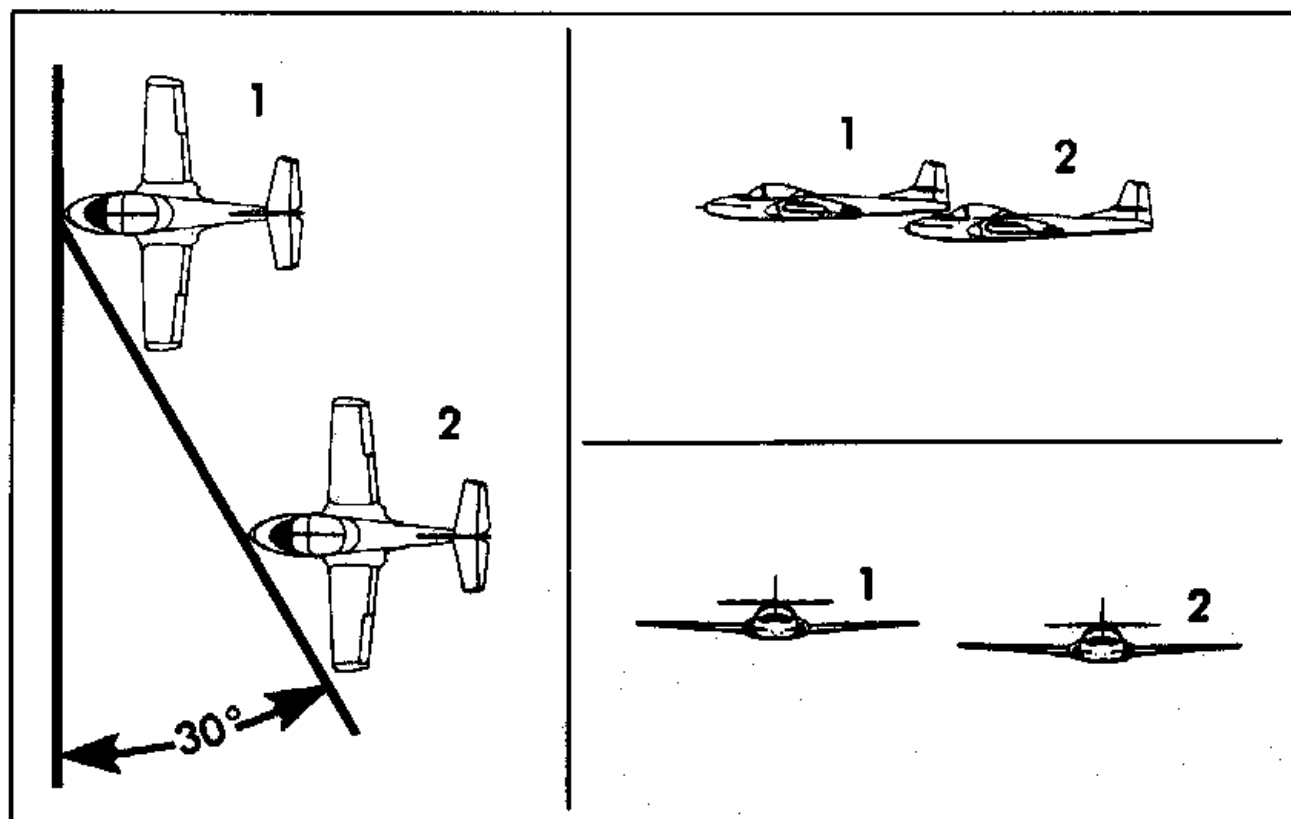


Figure 8.1. Fingertip Formation.

allowing airspeed to increase. Lead makes the first turn at a minimum of 150 KIAS and a safe altitude.

8.10.7. If lead aborts the takeoff after the brake release, the wingman normally continues the takeoff. For this reason, as the wingman, you must maintain proper wingtip clearance when lining up on the runway and throughout the takeoff. If the wingman or lead must abort the takeoff, he or she maintains lateral control of the aircraft, follows abort procedures, and, if time permits, calls on the radio with intentions. The fact that one aircraft develops trouble when breaking ground and decides to abort does not make it necessary for both aircraft to do so.

8.10.8. After the formation is airborne, it may become difficult for the wingman to determine that lead is experiencing an in-flight emergency (loss of thrust, etc.), which requires an abort or emergency landing. If the wingman overruns lead, lead will direct the wingman to assume the lead. The wingman will select full military power and make a separate takeoff while maintaining his or her side of the runway. The original lead will be responsible for in-flight separation and direct appropriate measures to regain flight integrity or initiate lost wingman procedures. The original

wingman will fly the briefed departure until instructed otherwise by the original lead.

8.10.9. As the wingman, if you drop behind on takeoff, you may not have sufficient airspeed to rotate with lead. In this case, cross-check your airspeed indicator and make your own takeoff. Rejoin on lead after becoming safely airborne.

8.10.10. As the wingman, if you must make a separate takeoff due to excessive crosswind (maximum crosswind component for a formation takeoff is 13 knots (70 knots nose wheel lift-off; touchdown (NWLO/TD)) or other factors, use a 10-second delay.

8.10.11. Formation members must use caution during takeoffs in gusty wind conditions for rapidly changing wind direction and velocity. Use timely corrections to maintain directional control and ensure aircraft separation.

8.11. Join Up After Takeoff. If aircraft take off separately (an "interval takeoff," using 10-second spacing), local procedures will dictate this type of rejoin. Use a turning rejoin, a straight-ahead rejoin, or, in some cases, a combination of both. After lead is airborne with a minimum of 150 KIAS, reduce power to approximately 95 percent and

accelerate to tech-order climb speed. Initially, the wingman will use military power. Be alert for transitions from one type of rejoin to another as lead follows the departure route.

8.12. Instrument Trail Departure. During trail departures in IMC, basic instrument flying is the first priority and will not be sacrificed while performing secondary trail tasks. Strictly adhere to the briefed climb speeds, power settings, altitudes, headings and turn points. If task saturation occurs, cease attempts to maintain trail, immediately concentrate on flying the instrument departure, and notify lead.

8.12.1. Takeoff spacing will be no less than 20 seconds.

8.12.2. Each aircraft or element will climb at 180 KIAS with 98 percent power unless briefed otherwise; 30° of bank will be used for all turns.

8.12.3. Until join up or level off, each aircraft or element will call when passing multiples of 5,000 feet and when initiating heading changes. Acknowledgments are not required, but monitoring radio transmissions and the progress of the succeeding aircraft or elements is imperative. Immediately correct any deviations from the departure route.

8.12.4. During the climb and through level off, each aircraft or element will maintain the briefed spacing using NAVAIDs and all available aircraft systems, including the clock.

8.12.5. Each aircraft or element will maintain at least 1,000 feet of vertical separation from the preceding aircraft or element except where departure instructions specifically prevent compliance. If the wingman cannot comply with the minimum safe altitude, lead may reduce the vertical separation to 500 feet.

8.12.6. If a visual join up cannot be accomplished at level off, lead will request 1,000 feet of altitude separation for each succeeding aircraft or element, if all aircraft can comply with the minimum safe altitude.

8.12.7. Wingmen will accomplish a rejoin only after visually acquiring lead and receiving permission to rejoin.

8.13. Fingertip Formation. This type of formation flying will form a basis for all your formation flying (figure 8.1).

8.13.1. Position. The fingertip position is flown on an angle approximately 30° back from the leader with approximately 3 feet of wingtip

clearance (figure 8.1). One reference to maintain longitudinal position is to align the pilot's head in the lead aircraft with the outside flap hinge. As a vertical reference, you should see approximately one-half of the ejection triangle or approximately one-third of the top of the wing and two-thirds of the bottom (figure 8.2). When you have 3 feet of wingtip spacing, you will barely see the trailing edge of lead's opposite elevator. These are only a few of many references. Your IP will point out others. Do not stare at one reference. Look at the whole aircraft and clear through your lead. Scanning from reference to reference will help you detect small changes in position. You must be on the 30° line for your vertical and lateral references to be accurate.

8.13.2. Technique. Good formation is the result of anticipation, planning, and the application of small corrections. Detect shifts in position promptly and stay in formation. Always keep the aircraft trimmed and coordinated. This is one of the most important fundamentals of good formation flying. In turns, the wingman maintains the same relative position as in level flight with respect to lead (figures 8.3 and 8.4). As the wingman, when lead turns away from you, increase back pressure and climb to maintain your vertical position. This requires an increase in power to maintain your airspeed and position on the 30° line. When lead stops the roll in, you have to take off some of the power you added because you are no longer climbing. When lead turns toward you, add slight forward pressure to maintain vertical position and reduce power to stay on the 30° line. Be aware of collision potential at all times. In turbulence, while flying maximum performance maneuvers or maneuvers which are not frequently flown (for example, pushovers at less than 1 G), the collision potential increases. During pushover maneuvers, your ability to counteract movement toward lead will be limited with near zero or negative Gs. For example, bank alone in 0 G conditions will not produce a heading change. Under these conditions, avoid wingtip vortexes because a rapid roll into the leader may develop. Should a breakout become necessary, use rudder, aileron, power, and speed brake as the situation dictates. Break out in the direction that will ensure immediate separation.

8.14. Crossunder. The purpose of performing a crossunder is to efficiently and safely move from one wing position to the opposite wing position. A crossunder may be accomplished from either fingertip or route formation positions. To fly good crossunders, you must anticipate each power change and make the smallest possible changes in

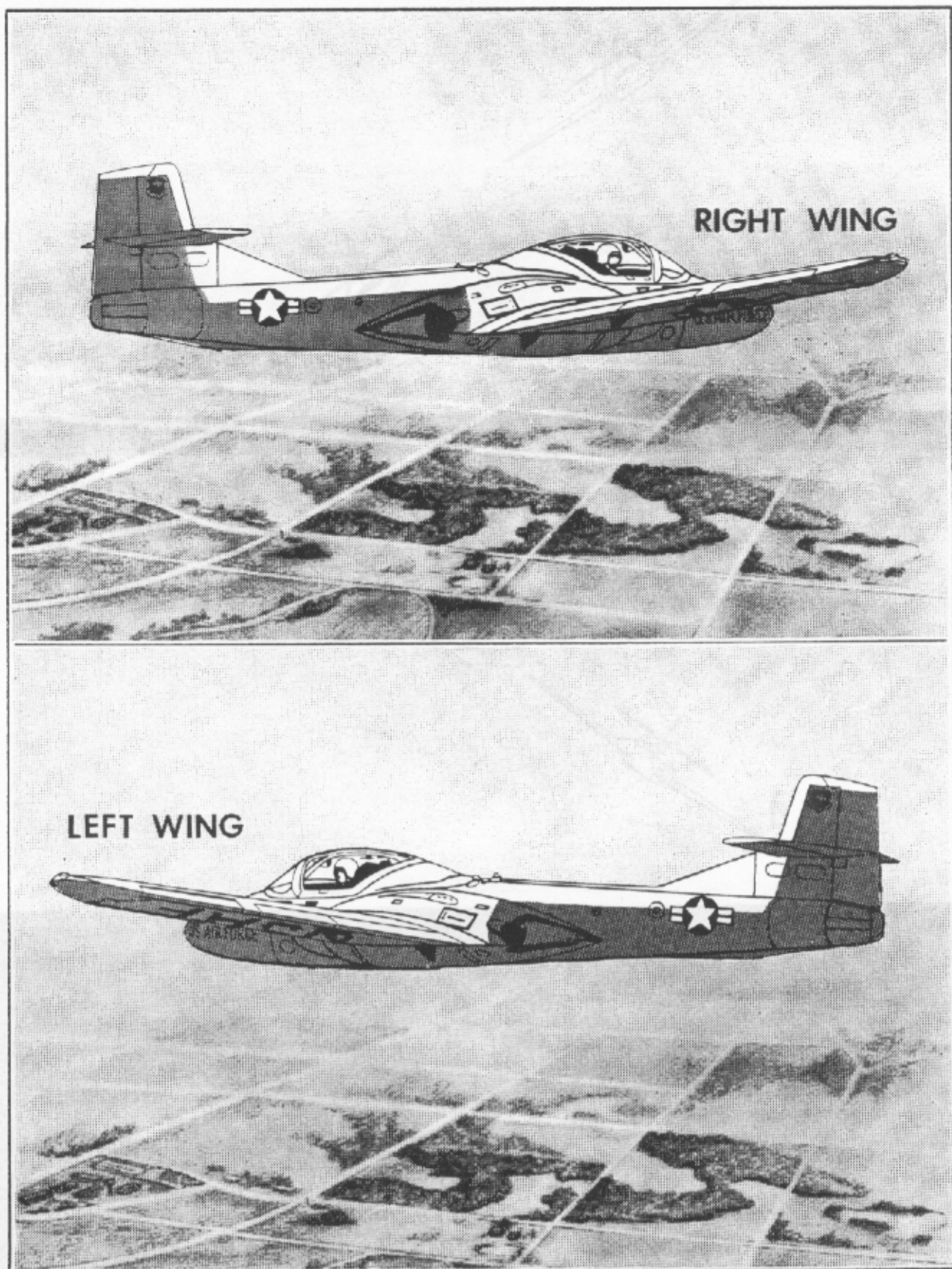


Figure 8.2. Fingertip Formation.

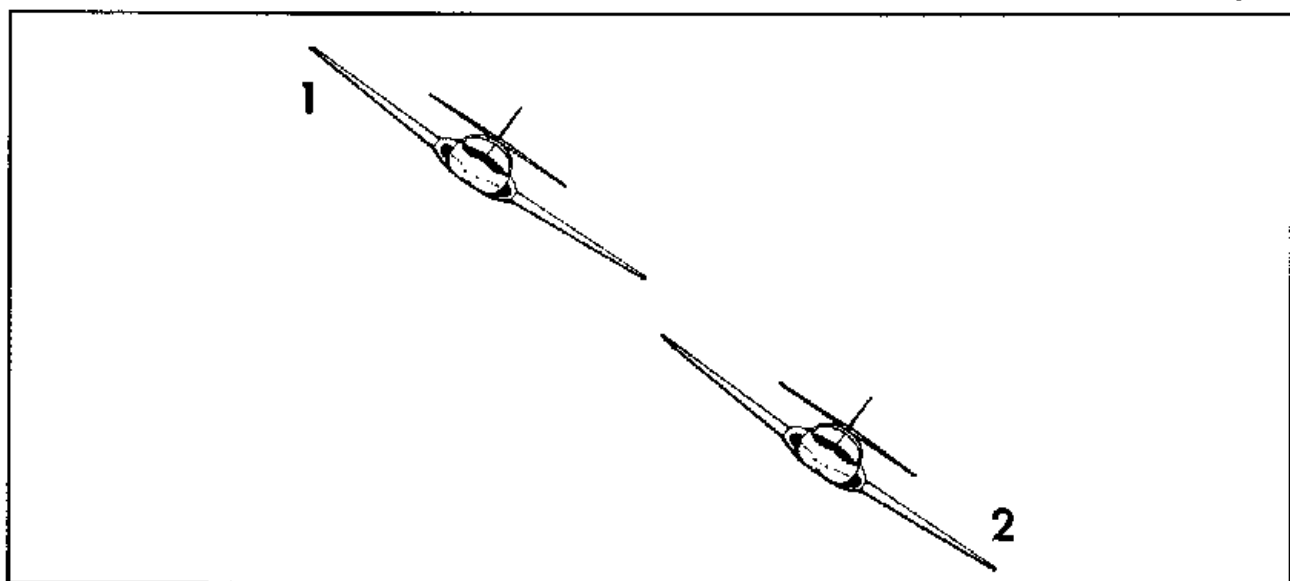


Figure 8.3. Turn-Into Position.

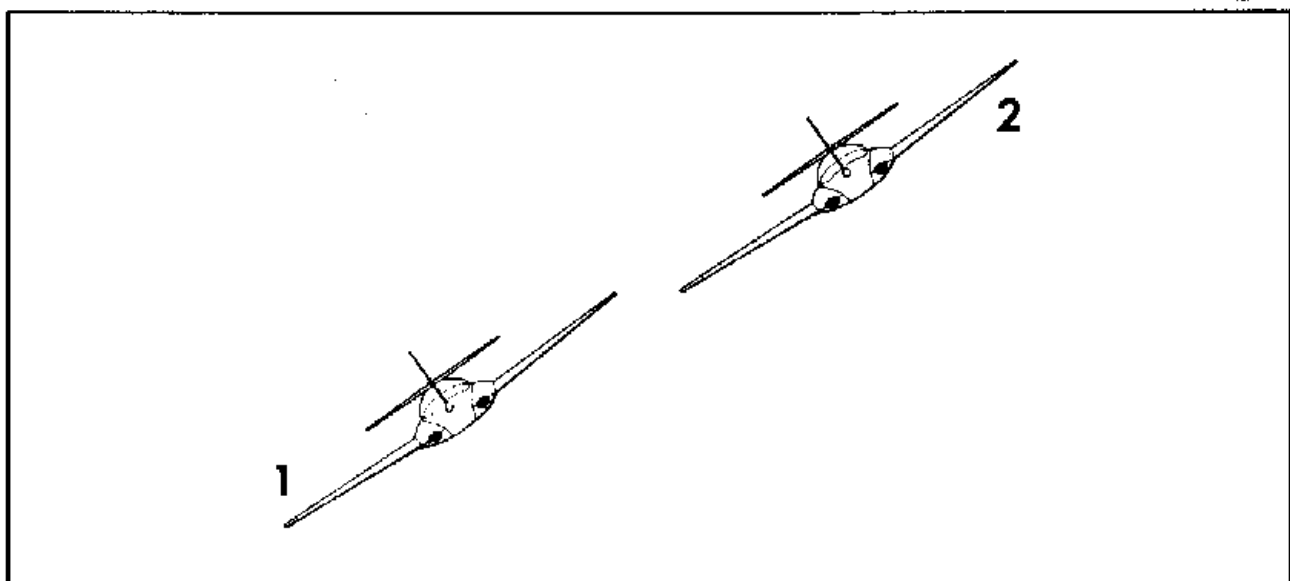


Figure 8.4. Turn-Away Position.

pitch and bank. Crossunders may be completed during turns when you are proficient. Do not pass under lead. Lead signals for a crossunder by dipping a wing in the desired direction of change (figure 8.5). Use the following procedures when accomplishing the crossunder from fingertip:

8.14.1. Reduce power slightly and, as airspeed is reduced, move a few feet lower than normal position.

8.14.2. Move aft to obtain nose-tail clearance; then increase power slightly to maintain this spacing. (Anticipate the power increase to prevent falling too far behind.)

8.14.3. Bank slightly toward the new position to change the aircraft heading a few degrees. Roll wings level, and fly to the opposite side. A heading change of only 1° or 2° will cause the aircraft to fly smoothly from one side of lead to the other. Keep proper nose-tail clearance with power; a power increase is necessary to maintain this clearance. Do not cross directly under any part of lead's aircraft! With proper clearance from lead, your canopy bow should appear superimposed on lead's taillight.

8.14.4. When you have wingtip clearance, return to lead's heading. Add power; and, as you move forward, move up to attain proper pitch references.

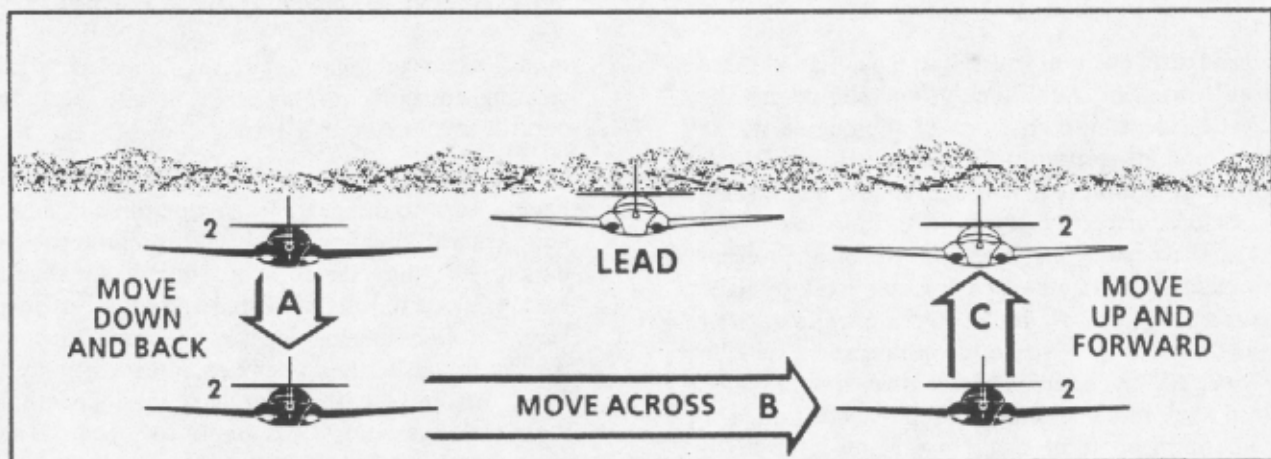


Figure 8.5. Crossunder.

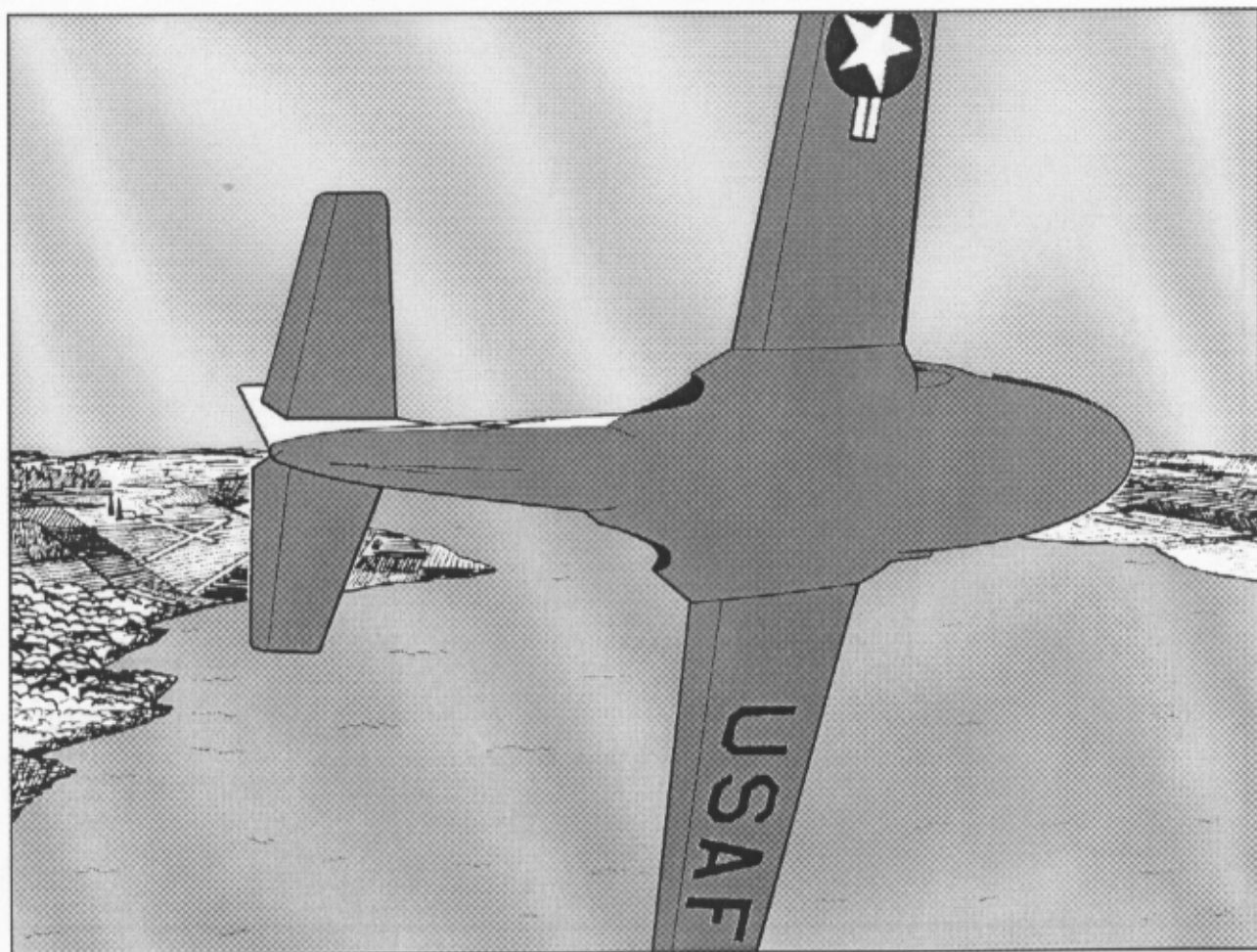


Figure 8.6. Echelon.

As you approach the fingertip position, reduce power to stop in position.

8.15. Echelon. Echelon is a variation of fingertip (figure 8.6). Lead will direct the formation to enter

echelon turns by radio call or visual signal. Echelon turns are always made away from the wingman. Lead should roll in smoothly and maintain back pressure commensurate with bank angle. As the wingman, you should match lead's roll rate. For

a level turn, position yourself so the horizon bisects lead's fuselage. Additionally, you should see the ejection decal just in front of the engine intake (fore and aft reference). Distance between aircraft (measured fuselage to fuselage) should be the same as before turn entry. If out of position, use power to make corrections fore and aft, back pressure to maintain horizontal spacing, and bank to make corrections up or down. During rollout, lead should use a slow, smooth roll rate and gradually reduce back pressure. The wingman should match lead's roll rate and maintain relative position. The maximum angle of bank in echelon is approximately 60°.

8.16. Route Formation. Route formation provides flexibility. It allows the wingman to check aircraft systems and personal equipment, look around, or simply relax. With the formation in route, lead should restrict maneuvering to moderate turns and pitch changes. Maximum bank angle in route is approximately 60°.

8.16.1. Route is an extension of fingertip. As the wingman, fly with the lateral spacing of two ship widths to 500 feet. Fly no farther aft than the normal fingertip line, no farther forward than line abreast, and vertically the same as fingertip. Go to route when lead directs or gives the loosen formation signal.

8.16.2. As the wingman, on the inside of the turn, descend only as necessary to keep lead in sight and stay below lead's plane of motion. When on the outside of the turn, maintain the same vertical references used in echelon. During turns, you may need to maneuver behind the fingertip line to maintain spacing and keep sight of lead. Do not cross to the opposite side unless directed by lead. Route crossunders may be directed with a radio call or wing dip.

8.16.3. When lead directs a move to route formation from fingertip for radio channel changes, in-flight checks, or position changes, wingmen will fly two- to four-ship-width spacing unless briefed otherwise. During rejoins, wingmen will stabilize in a route position with two to four ship-widths spacing before closing to fingertip.

8.17. Pitchout. The purpose of the pitchout is to provide spacing for rejoin practice.

8.17.1. Lead. The pitchout signal is the same as the signal for engine runup. Clear in the direction of the desired turn, and begin a turn away from the wingman, using approximately 60° of bank. Continue the turn for approximately 180°. Although a level pitchout is desired, you may make

modifications to your energy level. Do not sacrifice clearing in order to maintain precise altitude control or an exact 180° turn.

8.17.2. Wingman. Delay up to 5 seconds; then begin a turn to duplicate lead's rate of roll, bank, and general flightpath. After turning approximately 90°, play the turn by varying bank and back pressure to roll out behind and slightly below lead. An alternate method for obtaining spacing for rejoins may be used when circumstances permit. Lead will direct the flight to take spacing. Acknowledge and drop back to obtain the appropriate spacing.

★8.18. Maneuvering Fundamentals. The remaining parts of this chapter deal with maneuvering one aircraft in relation to another. Although not always apparent, two basic parameters apply to every situation where two or more aircraft maneuver three-dimensionally in relation to each other. These parameters are aspect angle and angle off. As you read the remaining parts of this chapter and progress in the formation category of training, you will begin to see all the applications of these principles.

8.18.1. Glossary. The glossary below lists the definition of these parameters and other terms used to describe maneuvering fundamentals throughout the remainder of this chapter.

8.18.1.1. Angle Off. The relative nose position of two aircraft. The angular distance between the longitudinal axis of the wingman and the longitudinal axis of the leader. Sometimes referred to as heading crossing angle (HCA) (figure 8.7).

8.18.1.2. Aspect Angle. The relative position of the wingman to the leader without regard to the wingman's heading. The angle measured from the tail of lead to the position of the wingman. *It is not a clock position off of lead* (figure 8.7).

8.18.1.3. Closure. The rate of movement the wingman has in relation to lead. Increasing closure is a result of greater airspeed, a lead pursuit curve, or both. Conversely, decreasing closure is a result of lesser airspeed, a lag pursuit curve, or both.

8.18.1.4. Lag Pursuit Curve. The path a wingman's aircraft will follow if it flies to an imaginary point behind lead (figure 8.7).

8.18.5. Lead Pursuit Curve. The path a wingman's aircraft will follow if it flies to an imaginary point in front of lead (figure 8.7).

8.18.1.6. Line of Sight (LOS). A line from the pilot's eye to an object being viewed.

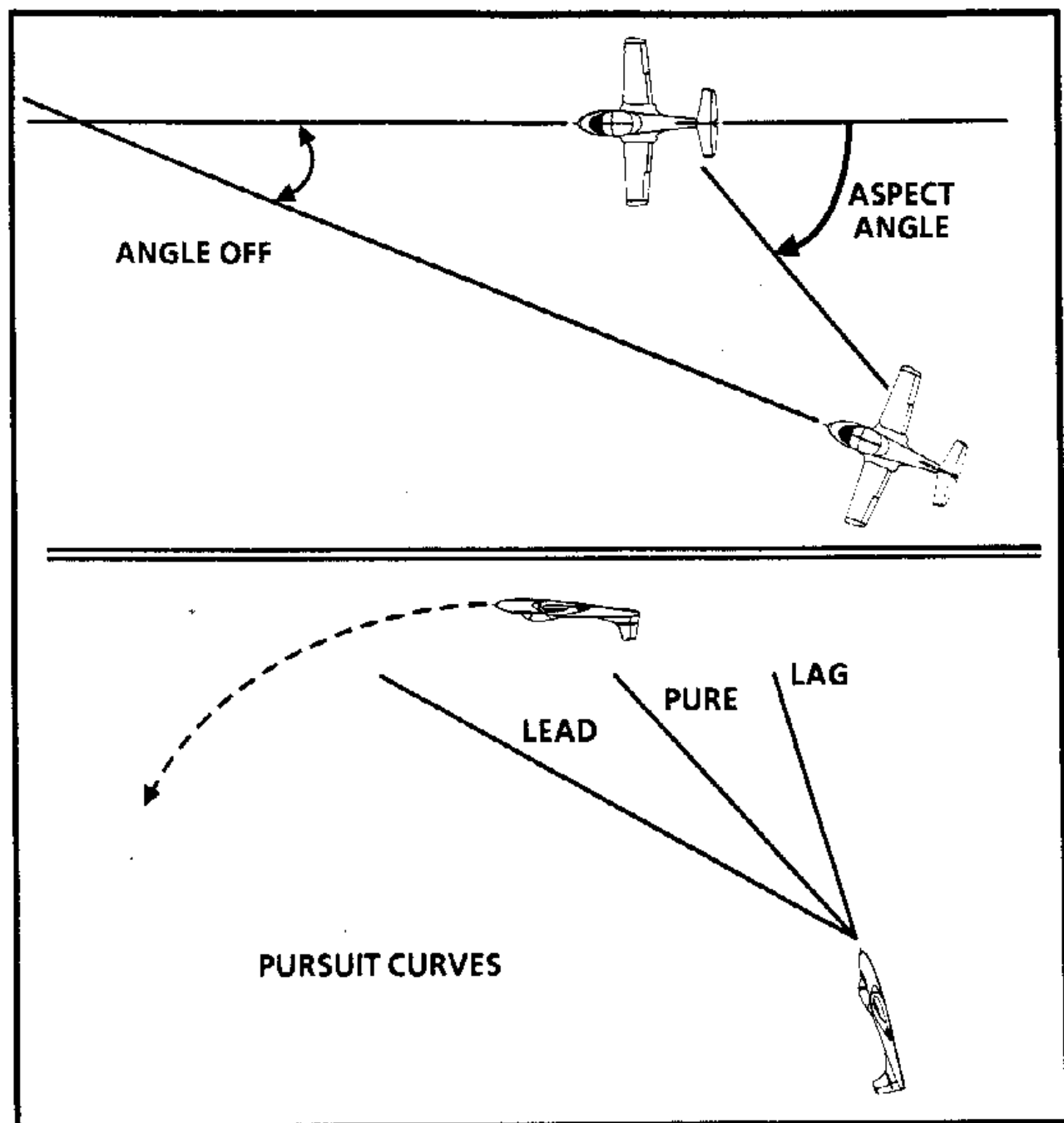


Figure 8.7. Maneuvering Fundamentals (Aspect Angle Versus Angle Off).

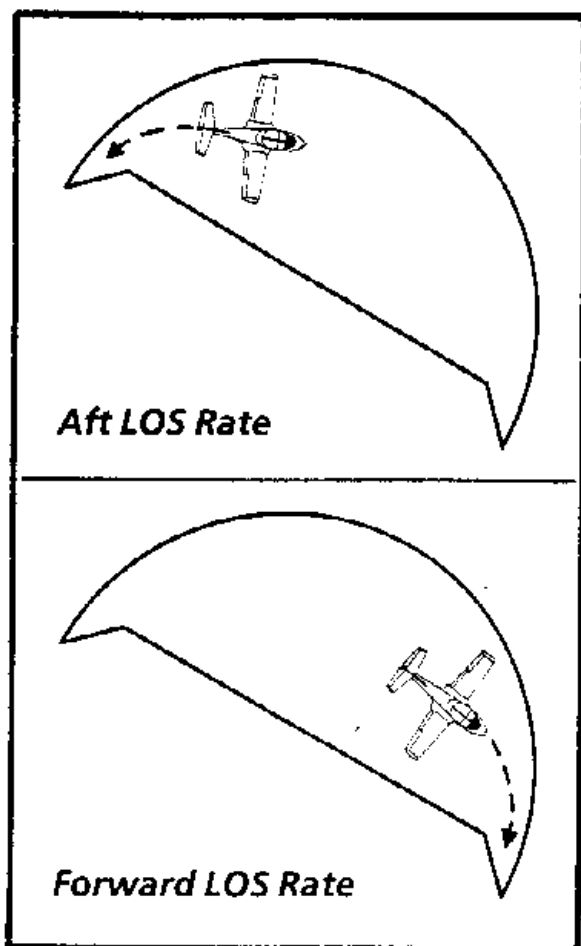
8.18.1.7. LOS Rate. The rate of movement of the object along the canopy. An aft LOS rate occurs when your aircraft flightpath results in passing in front of the object. A forward LOS rate occurs when your aircraft flightpath results in passing behind the object (figure 8.8).

8.18.1.8. Pure Pursuit Curve. The path a wingman's aircraft will follow if it flies directly at the lead aircraft (figure 8.7).

8.18.2. Specific Pursuit Curves. Lead, lag, and

pure pursuit curves control aspect angle and angle off. Although these air-to-air principles are complex in the everchanging combat arena where very few absolute rules exist, the following basic relationships apply in the controlled training environment. These relationships are summarized in figure 8.9.

8.18.2.1. With lead pursuit, the wingman points in front of lead. Lead's aircraft will create an aft LOS rate across your canopy. This decreases angle



★Figure 8.8. LOS Rate.

off, increases aspect angle, and creates closure. If carried to an extreme, lead pursuit will result in the wingman flying past lead.

8.18.2.2. With lag pursuit, the wingman points behind lead. Lead's aircraft will create a forward LOS rate across your canopy. This increases angle off, decreases aspect angle, and decreases closure. Ultimately, spacing will increase between wingman and lead aircraft.

8.18.2.3. With pure pursuit, the wingman continually points at lead. Lead's aircraft will remain stationary on your canopy. This does little to control aspect angle or angle off, but it does create closure. However, the closure rate created by pure pursuit is less than the closure rate created by lead pursuit.

8.19. Rejoins. Rejoins are used to get the aircraft into fingertip as safely and expeditiously as possible. Rejoin airspeed is 190 knots unless otherwise briefed.

Pursuit Curve Relationship Chart				
Pursuit Curve	Aspect Angle	Closure	Angle Off	Line of Sight
Lead	Increases	Increases	Decreases	Aft
Lag	Decreases	Decreases	Increases	Forward
Pure	—	Increases	—	—

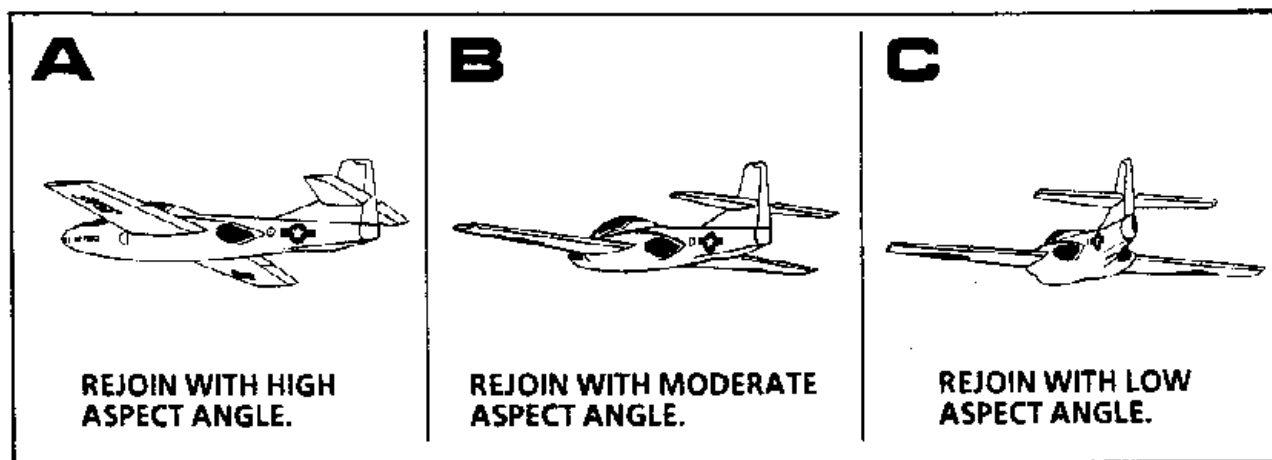
★Figure 8.9. Pursuit Curve Relationship Chart.

8.19.1. Lead. After rolling out of the pitchout, wait long enough for your wingman to roll out in trail. Signal for a rejoin by either a radio call or by rocking your wings. Establish a turn, using approximately 30° of bank, and adjust power and pitch as necessary to maintain rejoin airspeed. If you want to change the prebriefed airspeed, call the airspeed you will hold. Hold bank and pitch stable to assist the wingman. During the rejoin, monitor the wingman and clear the area.

8.19.2. Wingman. When lead gives the rejoin signal and enters a turn, start a turn in the same direction. Use approximately the same angle of bank as lead, and pull lead pursuit until you approach the desired aspect angle. Stay slightly beneath lead's altitude at all times so both pilots can keep lead in sight. A power increase will also expedite the rejoin.

★8.19.2.1. As you move inside lead's turn, you will notice his or her vertical stabilizer appears to move toward the outside wingtip as the aspect angle increases. When the vertical stabilizer approximately bisects the outside wing, reduce your angle of bank to maintain this reference. If the vertical stabilizer appears to move toward the wingtip, your aspect angle is increasing. To correct this, shallow your bank (less lead or maybe lag pursuit). If the vertical stabilizer appears to move toward the wing root, your aspect angle is decreasing; to correct this, increase your bank (lead pursuit). This reference will provide a reasonable cutoff during the initial phase of the rejoin. As you get closer to lead, the tail on the wing reference will change and the vertical stabilizer will appear to move toward the outside wingtip (figure 8.10).

8.19.2.2. The critical stage of the rejoin begins when you are approximately 500 feet from join up and slightly behind the 30° line. From this position, you will begin to see the normal fingertip references. To move toward lead, drop down slightly and move forward (lead pursuit) slightly onto an extension of the fingertip line. Begin



★ Figure 8.10. Appearance of Lead from Various Angles.

decreasing the overtake airspeed with a power reduction and speed brake as necessary. Monitor bank and overtake closely during the last few hundred feet before join up to ensure your movement is controllable. Plan to arrive in the route position with airspeed the same as lead. Stabilize in this position; then move into fingertip at a controlled rate.

8.19.2.3. To rejoin on the outside of the turn (number three position), plan to pass behind (at least two ship lengths) and below lead. Stabilize two to four ship widths out in the route position. Then move into fingertip at a controlled rate.

8.20. Straight-Ahead Rejoins:

8.20.1. Lead. After the pitchout, call for a straight-ahead rejoin. The wingman will rejoin to the side you direct. (If not specified, the wingman will rejoin to the left side.) Announce the airspeed if it differs more than 10 knots from that prebriefed.

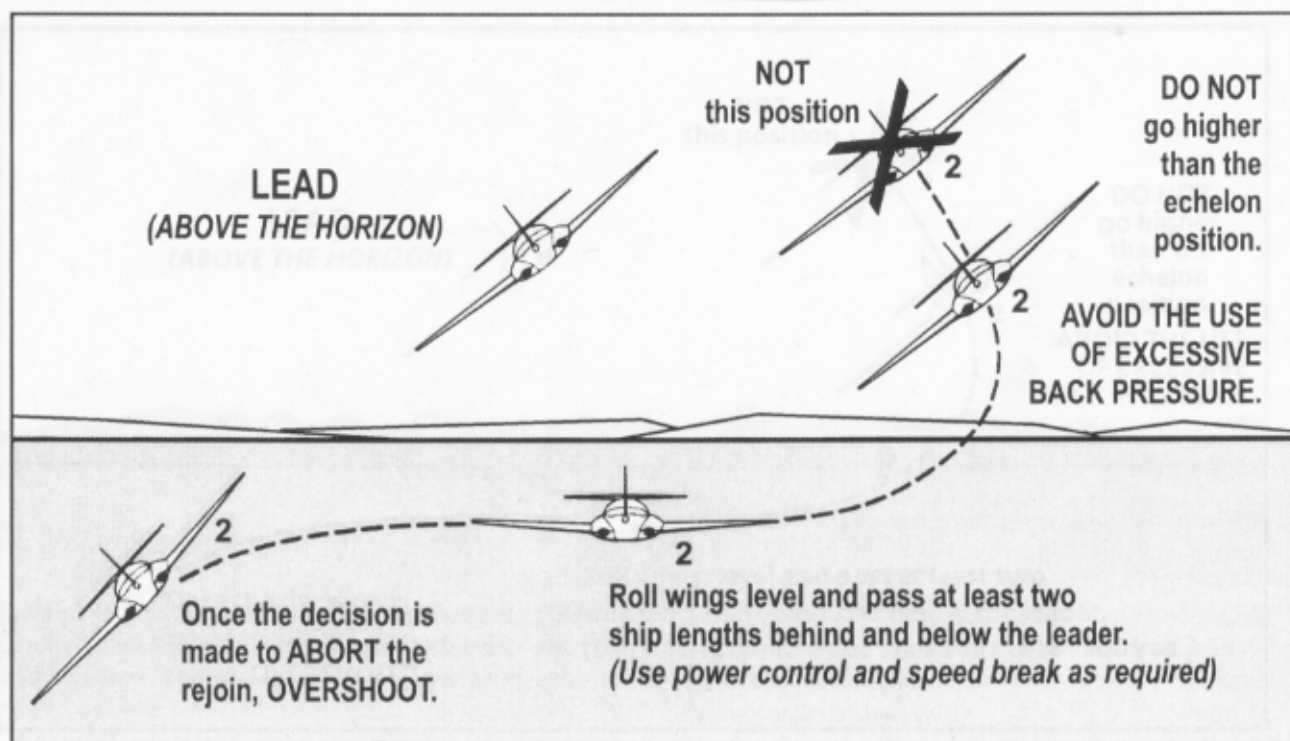
★**8.20.2. Wingman.** Initially use power as necessary, and move below and slightly to the left side or as designated by lead. Your flight path should angle away from lead to the route position. Do not drive up lead's 6 o'clock. Continue to close until you are approximately 1,500 feet to the rear of leader. From this point, begin decreasing the overtake speed with a power reduction and plan to arrive in the route position with airspeed the same as lead's. After matching speed in the route position, move into the fingertip position. If lead must turn during a straight-ahead rejoin, transition to a turning rejoin and be alert for overshoot situations because you may have both a cutoff and airspeed advantage.

8.21. Overshoot:

★**8.21.1. Turning Rejoin.** If, despite reduced power and use of the speed brake, an overshoot develops, the wingman stays low enough to keep lead in sight and use lag pursuit to move outside of the turn with at least two ship lengths of nose-tail clearance (figure 8.11). The greater the closure rate, the wider the wingman must go to prevent moving forward of lead's position. As the wingman, once outside the turn, do not move forward of lead's position. Avoid excessive back pressure because this will cause you to close on lead. Go no higher than lead. After momentarily stabilizing, return to the inside of the turn with a minimum of two ship lengths of nose-tail clearance on the lead aircraft, and complete a normal join up. During an overshoot, lead should keep the wingman in sight if practical and must provide a stable platform for number two. However, if a collision appears imminent, lead must take positive action to prevent a midair collision.

8.21.2. Straight-Ahead Rejoin. As the wingman, if your closure rate is excessive during the straight-ahead rejoin, reduce power and use the speed brake as required to establish a safe closure rate. If you are going to overshoot, maintain lateral separation by turning away slightly from the formation leader. Keep lead in sight. (If you overshoot to the point that it becomes difficult to keep lead in sight, break out of formation.) Resume the rejoin when lead begins to move ahead. When overshooting straight ahead, there is a tendency to move the control stick in the direction you are looking; that is, toward lead. If uncorrected, this action may cause your aircraft to pass in front of or below lead, resulting in one of the mandatory breakout situations (paragraph 8.22).

8.22. Formation Breakout:



★Figure 8.11. Overshoot.

★8.22.1. The purpose of a breakout is to ensure immediate separation and to avoid a midair collision. The wingman must break out of formation when directed, when visual contact with lead is lost causing a loss of situational awareness, when unable to rejoin to or remain in formation without crossing under or in front of lead, or anytime his or her presence constitutes a hazard to the formation.

8.22.2. Use caution whenever passing under lead or viewing lead through the top of the canopy. This situation may cause disorientation.

★8.22.3. When breaking out, the wingman clears in the direction of the break and notifies lead. If breaking out due to a lost-sight situation, the wingman breaks away from lead's last known position or direction of turn, or in the direction that ensures immediate separation using power as required to maintain a maneuvering airspeed and (or) speed brakes to expedite the separation. Lead will continue the current maneuver with the current power setting to aid in aircraft separation. If the wingman is in sight, lead should also maneuver to obtain separation whenever possible. After obtaining a safe separation and when no further complications exist, the wingman may request a rejoin. However, the wingman should not rejoin until directed to do so.

8.22.4. If breaking out of formation on final

approach, a rapid increase in back pressure can quickly result in a stall. Also, abrupt application of excessive rudder can cause the aircraft to roll past the desired bank angle. This can further aggravate the low speed condition and reduce the chances of a successful recovery.

★8.22.5. The wingman may encounter a hazardous situation in which an aggressive breakout is inappropriate. For example, if the aircraft drifts into a position dangerously close to lead, an aggressive breakout may possibly result in a collision. In this situation, the wingman should move away from lead, using smooth and positive control inputs as required.

★8.23. **Lost Sight.** In some cases, losing sight of the other aircraft does not require a breakout or lost wingman procedure because sufficient spacing already exists; for example, following a pitchout. However, if the other aircraft is not in sight when anticipated, use the following procedures:

8.23.1. Notify the other aircraft of your situation, and state your current altitude; for example, "Curly 2 is blind, 17,000 feet." In some cases, heading or turn information may also be appropriate for this call.

8.23.2. If the other aircraft has not lost sight, transmit that fact with a relative position to the "blind" aircraft; for example, "Curly 1, visual,

right, 2 o'clock, high." If lead is the "blind" aircraft, but the wingman has lead in sight, lead has the option to direct a rejoin. In this case, the wingman will not rejoin closer than a route position until lead has called "visual."

8.23.3. If both aircraft have lost sight of each other, lead will immediately ensure a minimum of 1,000 feet of altitude separation. Both members will maintain this separation until making visual contact and initiating a rejoin.

8.24. Knock-It-Off Call. This is a radio call any formation member can make to terminate maneuvering for any reason. It is particularly applicable when a dangerous situation is developing. This radio call applies to all phases of flight and all types of formation maneuvers; and all formation members must acknowledge this call in turn; for example, "Curly, knock it off." Regardless of who made the knock-it-off call, lead will acknowledge with the call, "Curly 1, knock it off," followed by the wingman's call, "Curly 2, knock it off." The wingman should then await directions from lead.

8.24.1. Call "knock it off" any time one or more of the following situations exist:

8.24.1.1. The maneuver or exercise, if continued, would cause the formation to go out of the authorized area.

8.24.1.2. An unbriefed or unscheduled flight enters the working area and is detrimental to the safe conduct of the mission.

8.24.1.3. The minimum altitude or cloud clearance are approached (unless in a nonmaneuvering fingertip formation).

8.24.1.4. Situational awareness is lost.

8.24.1.5. A radio failure is recognized.

8.24.1.6. Any aircraft rocks its wings.

8.24.1.7. The desired learning objective is achieved.

8.24.1.8. A dangerous situation is developing.

8.24.1.9. The minimum fuel state or bingo fuel is reached.

8.24.1.10. An over-G occurs.

8.24.2. Lead will continue the current maneuver with the current power setting until directing a rejoin. This will ensure lead remains predictable and will aid in flightpath deconfliction. Since either aircraft can subsequently lose sight of the other, ensuring flightpath deconfliction should be the

primary concern for both aircraft.

8.24.3. If either aircraft subsequently loses sight of the other, the aircraft losing sight should make the appropriate lost-sight radio call, and both aircraft should follow lost-sight procedures (paragraph 8.23).

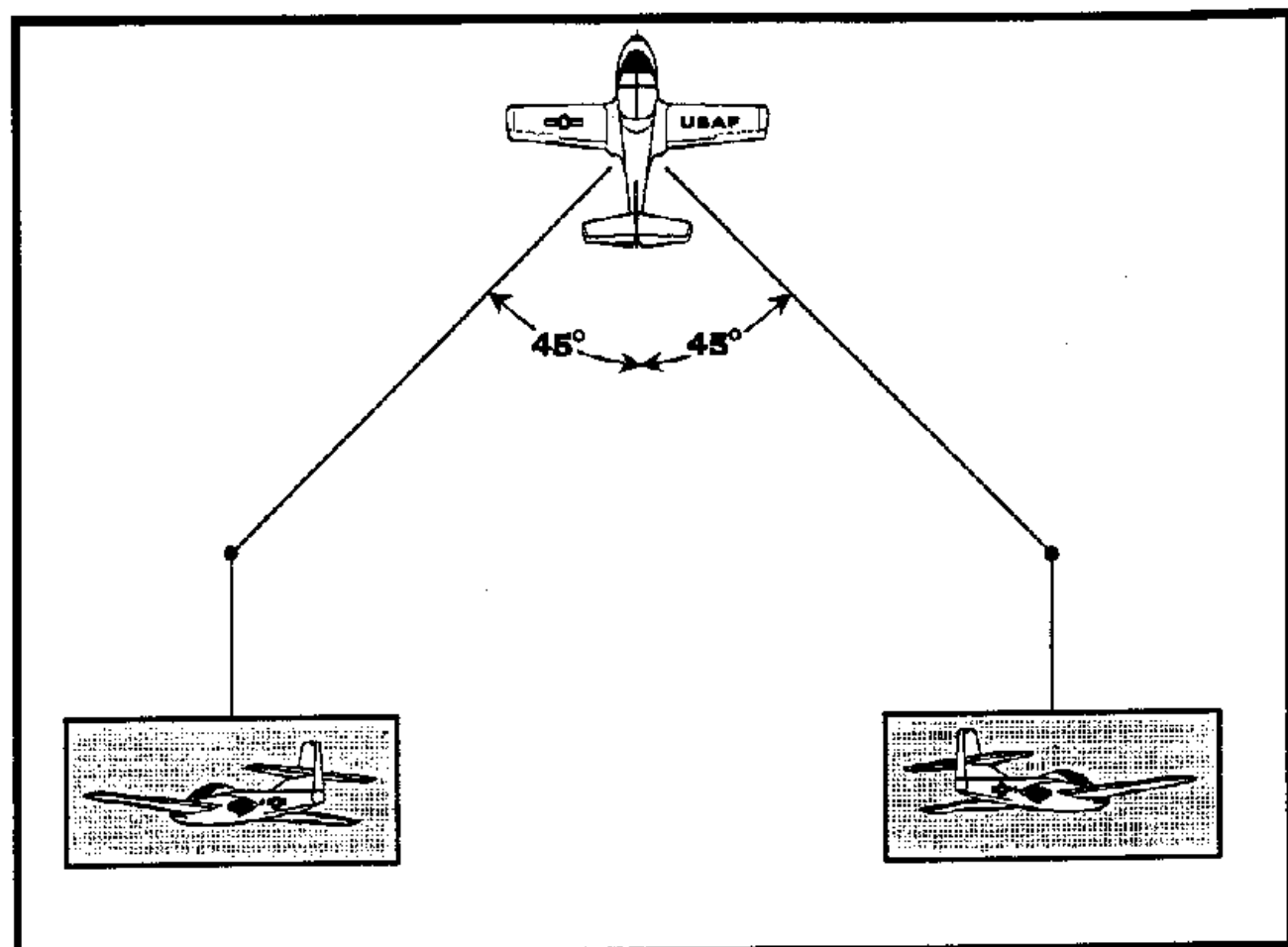
★8.24.4. If lead has the wingman in sight and the situation requires immediate aircraft separation, lead should maneuver to ensure separation between the two aircraft. Lead will direct a rejoin only after the wingman has reached a position from which a safe rejoin is possible. The wingman should maintain a minimum of 1,000 feet of separation until directed to rejoin. As the wingman, if an excessive closure rate is apparent, breakout or overshoot as appropriate to stay away from lead's flightpath.

★8.25. Offset Trail:

8.25.1. General. The primary purpose for flying offset trail is to develop your ability to use lead, lag, and pure pursuit curves to explore and practice three-dimensional maneuvering in relation to another aircraft. The ultimate goal is for you to demonstrate your understanding of pursuit curves, aspect angles, and closure control in order to establish and maintain your aircraft within specific offset trail parameters. The process of analyzing and solving these problems requires that you understand the consequences of flying each pursuit curve as described in paragraph 8.18.

8.25.2. Offset Trail Position. The offset trail position is 45° left and right of lead's 6 o'clock position and 300 to 500 feet aft of lead (figure 8.12). It is a fluid position in that the wingman may change sides to enhance maneuverability and maximize clearing in high density airspace and special situations, such as heavy bird activity, monitoring a distressed aircraft, or simply to give an alternate departure, cruise, or recovery position. Striving to maintain this position requires you to constantly analyze your aspect angle and closure in order to apply the proper amounts of lead and lag pursuit. The command to move your wingman to the offset trail position is given as a radio call or prebriefed visual signal, "Curly, go offset." The wingman acknowledges lead's transmission and maneuvers into position. Transitory periods in the leader's high or low 6 o'clock position while maneuvering to the other side are acceptable, but the wingman should avoid stagnating in the 6 o'clock position and instead concentrate on maintaining the 45° angle off of lead.

8.25.3. Offset Trail Exercise. The offset trail



★Figure 8.12. View of Lead from Offset Trail Position.

exercise is the culmination of your maneuvering fundamentals training. The basic principles of pursuit curves and closure control you learned during rejoins are expanded into a more fluid environment. The offset trail exercise allows your IP to show the relationship between lead, lag, and pure pursuit curves as they relate to aspect, range, and closure. Essentially, you will learn how to properly fly the appropriate pursuit curve to solve various problems of range, aspect, and closure that the lead aircraft will create. Learning how and when to transition from one pursuit curve to another to solve these problems requires that you understand basic concepts involving turn circle geometry, aspect awareness, and energy management. You must also remain aware of and be ready to use other methods to maintain position. For example, reduce power and extend speed brake to increase separation or make a knock-it-off call over the radio if too much spacing develops. Adhere to offset trail restrictions outlined in AETCI 11-201. Perform a G-awareness exercise as described in paragraph 5.14.3 of this manual before flying maneuvers in the offset trail exercise.

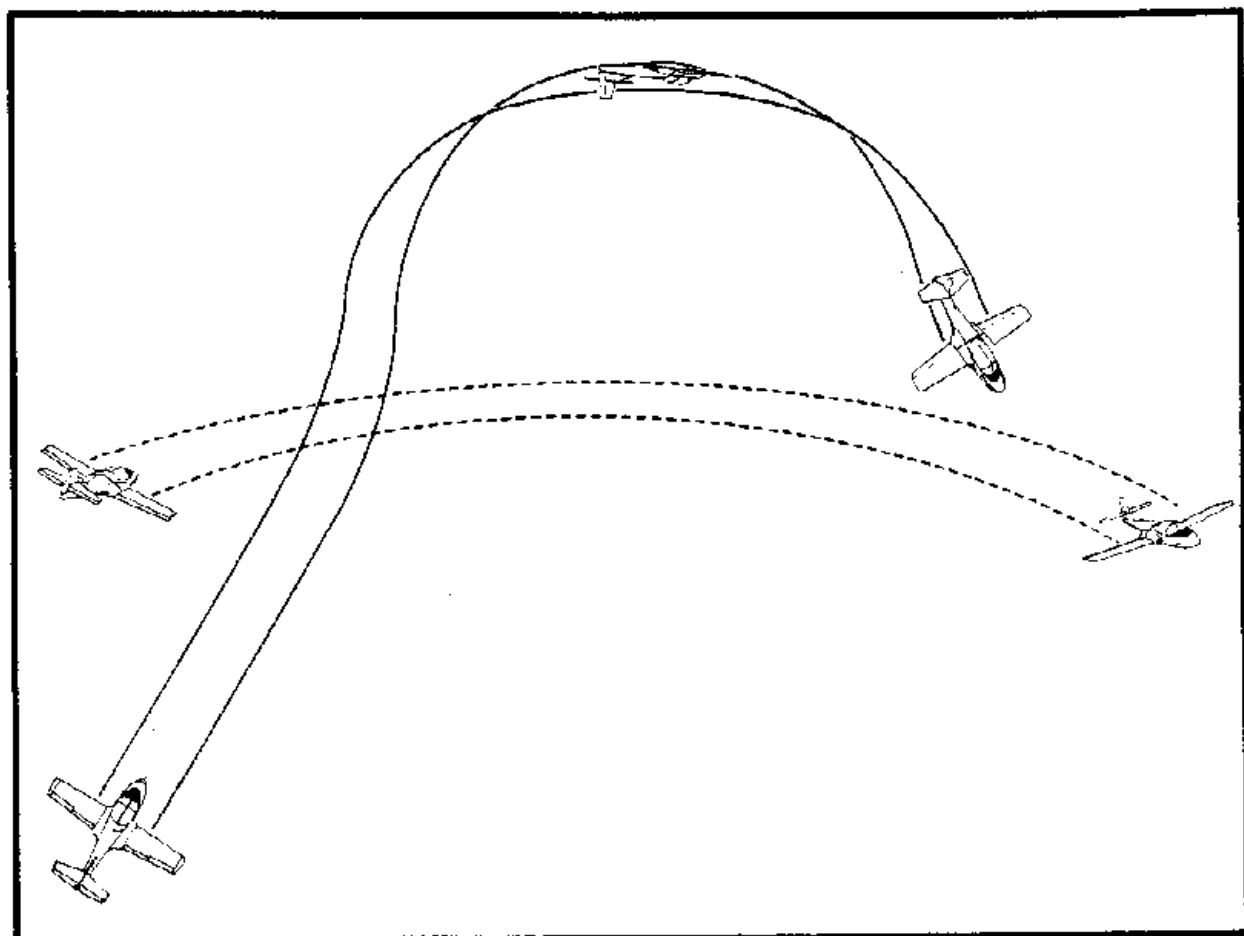
8.25.3.1. Glossary. The following is a glossary of terms used to describe some elements of maneuvering during offset trail.

8.25.3.1.1. High Yo-Yo. A reposition of your aircraft using a combination of pure or lag pursuit and movement above lead's plane of motion to control closure, decrease aspect, and prevent an overshoot. It also allows for turning room in a vertical plane of motion above the leader's plane of motion (figure 8.13).

8.25.3.1.2. Low Yo-Yo. A reposition of your aircraft using a combination of lead pursuit and movement below lead aircraft's plane of motion to increase closure. It will also increase your aspect angle (figure 8.14).

8.25.3.1.3. Plane of Motion. The geometric plane described by the flight path of an aircraft. At high G loading (above 4 Gs), the plane of motion is approximated by the lift vector.

8.25.3.1.4. Quarter Plane. An out-of-plane lag maneuver used to preserve the 3/9 line. This situation may be caused by a late decision or no



★Figure 8.13. High Yo-Yo.

decision to execute a high yo-yo, or failure to control closure. Indicators that a quarter plane is needed are similar to those of a high yo-yo; however, aspect, angle off, and closure are more severe and range is usually much closer (figure 8.15).

8.25.3.1.5. Rate of Turn. Rate of change of heading, normally measured in degrees per second.

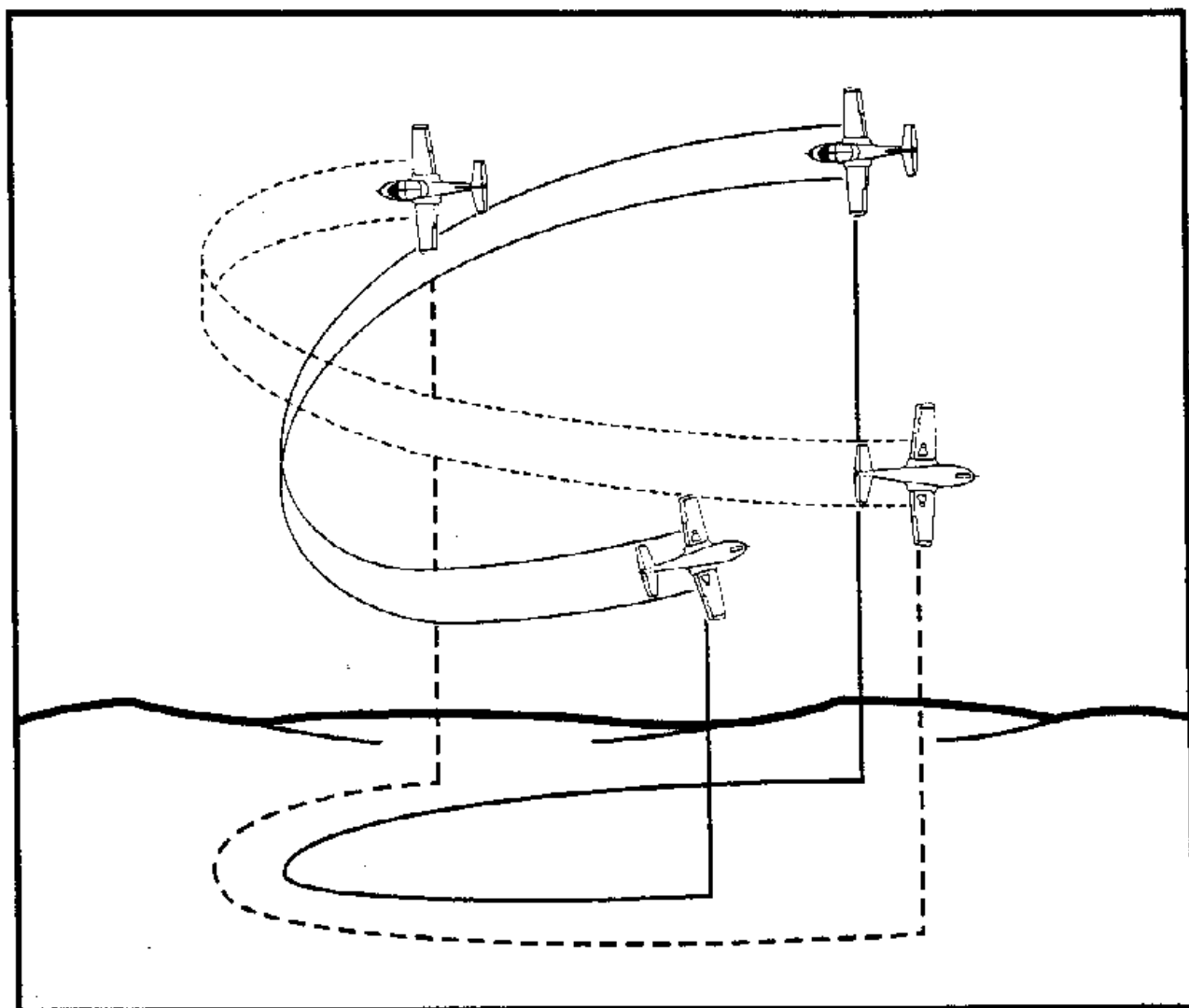
8.25.3.1.6. Three/Nine (3/9) Line. A hypothetical line extending out of the aircraft's lateral axis. The wingman must remain aft of lead aircraft's 3/9 line during maneuvering. This line equates to a 90° aspect angle (9 aspect) for a trailing aircraft.

8.25.3.1.7. Turning Room. Volume of airspace in the vertical, horizontal, or both which can be used to execute a maneuver for solving aspect, angle off, and closure when maneuvering in relation to another aircraft.

8.25.3.2. Turn Circle Geometry. During the offset trail exercise, you will analyze the geometry of lead's turn; such as, turn rate and turn radius, based on lead's airspeed, bank angle, and G loading. Lead's

turn geometry and how aggressively you fly a lead pursuit curve to move into position when entering the exercise will determine the aspect, range, and closure problems you must solve. In a level turn using 2 Gs, 60° of bank, and approximately 230 KTAS, lead's approximate turn rate and turn radius will be 8° per second and 2,500 feet, respectively. As the lead aircraft turns, its 3/9 line points to the center of the turn circle. The line continues through the center of the circle creating the diameter of that circle and defining the airspace in which the wingman must maneuver. Always remain in the airspace aft of the 3/9 line (figure 8.16). Lead will be flying close to the level turn parameters above until wingman reaches the offset trail position. The offset trail entry procedures should keep the wingman inside lead's turn radius and well within the proper half of lead's turn circle.

8.25.3.3. Aspect Awareness. Aspect recognition and turn circle geometry are equally important in determining how and when to fly the proper pursuit curve. During the offset trail exercise, you will analyze your aspect angle continually during the

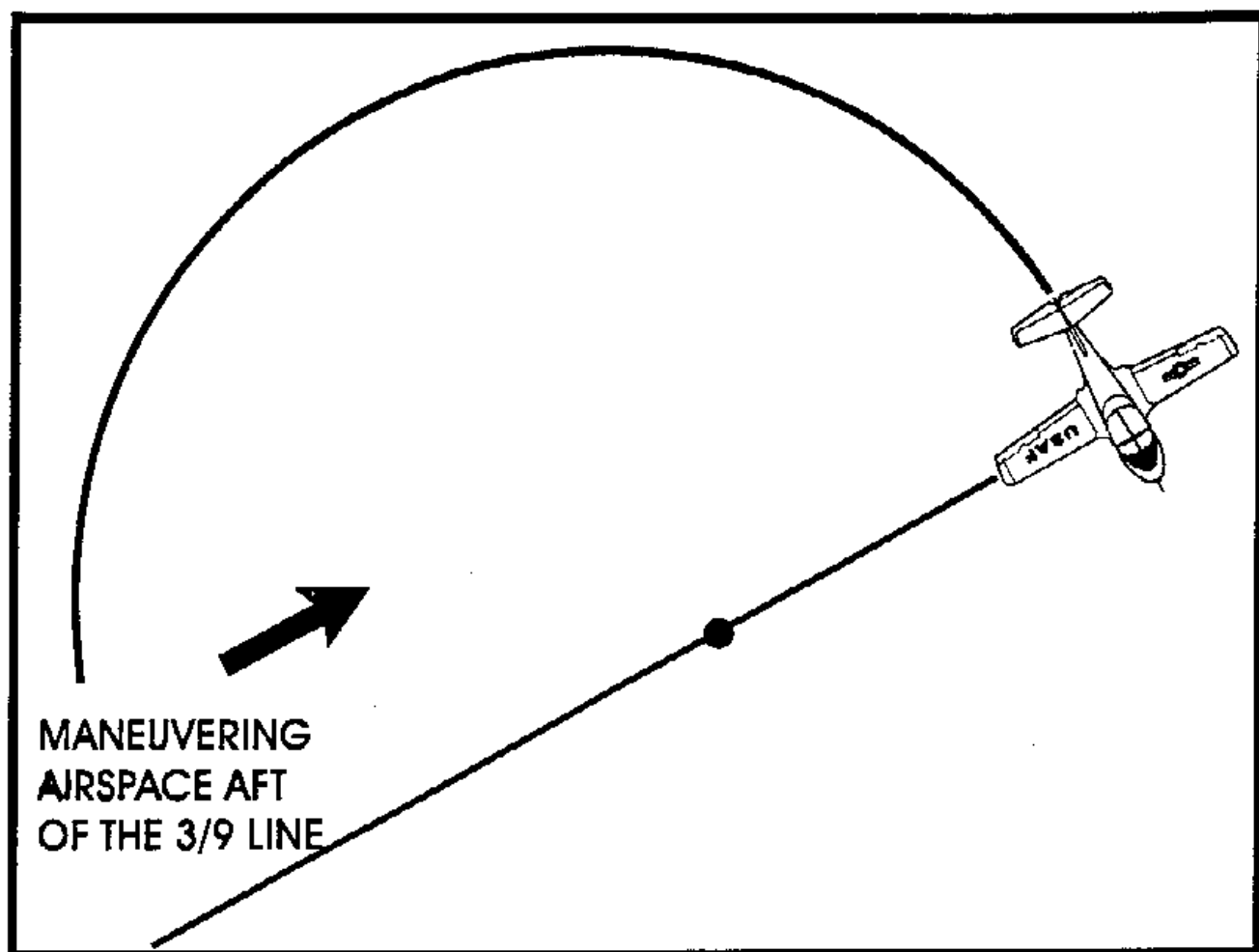


★Figure 8.14. Low Yo-Yo.

entry and maneuvering phases. Since the maneuvering area is limited up to but not forward of the 3/9 line, aspect angle will range from 0° to 90° when closing on lead during the entry. When lead is performing the lazy eight type maneuvers, the desired position is 45° left or right of lead. For simplicity, our aspect range is described from 0 to 9, left or right. Remember, aspect is not a clock position. The straight wing of the T-37 makes recognition of the 9 aspect line easy even at large distances. You are already familiar with the 6 aspect line since this is the extended fingertip line. A 4 aspect reference is the vertical tail on or slightly forward of the wing tip. When assessing your position in relation to lead, you must determine how aspect will change as you maneuver. Because of the T-37's small turn radius and fast turn rate, you must anticipate where your aircraft is going and maneuver to change your aspect prior to

reaching the desired aspect. Anticipation will help you avoid exceeding offset trail parameters. This is especially true when lead turns into you at the top of a lazy eight or when you initiate a low yo-yo to decrease range while entering the exercise. You must also be aware that lead aircraft is constantly changing your aspect angle and angle off for you through a continuous turning movement.

8.25.3.4. Energy Management. While maneuvering during the exercise, you will fly at various G loading that will challenge your energy management. There are several important areas in which you can assist in preserving and (or) gaining energy. During the entry, lead should begin with 180-200 knots. This will ensure the optimum turn rate for the wingman to analyze and enable lead to maneuver expeditiously once the wingman calls



★Figure 8.16. Airspace Aft of 3/9 Line.

energy. This is particularly effective when in lag pursuit with both aircraft in a descent. If you elect to reduce power at any time, take care not to reduce it too long to avoid getting too far out of position.

8.25.4.1. Entry:

8.25.4.1.1. Lead. When reaching 180-200 KIAS, direct the formation to begin offset trail maneuvering with the radio call, "Curly, go offset trail." After the wingman acknowledges the call, begin a moderate G turn of approximately 2-3 Gs away from the wingman. Initially, military power may be required to establish separation and preserve energy. Once separation is ensured, set the power at approximately 90 to 95 percent. Higher altitudes and air temperatures may require you to use military power to maintain an appropriate energy level. Allow adequate time for the wingman to roll out in a trail position with approximately 1,000 to 1,500 feet spacing. When ready to begin maneuvering, call "Curly 1's ready." When in position, the wingman will respond with "Curly 2's ready." Do not initiate the constant turn setup

for the exercise until the wingman calls "ready."

8.25.4.1.2. Wingman. To gain the proper separation for the type of training you have planned during the entry, delay 5 to 8 seconds after the lead turns away and then break in the same direction. To achieve 1,000 feet spacing, delay 5 to 6 seconds; for 1,500 feet spacing, delay the full 8 seconds. Use power as required, playing the last 90° of the turn to roll out at the proper spacing. Lead will delay initiating the constant turn setup until you call "ready."

8.25.4.2. Maneuver:

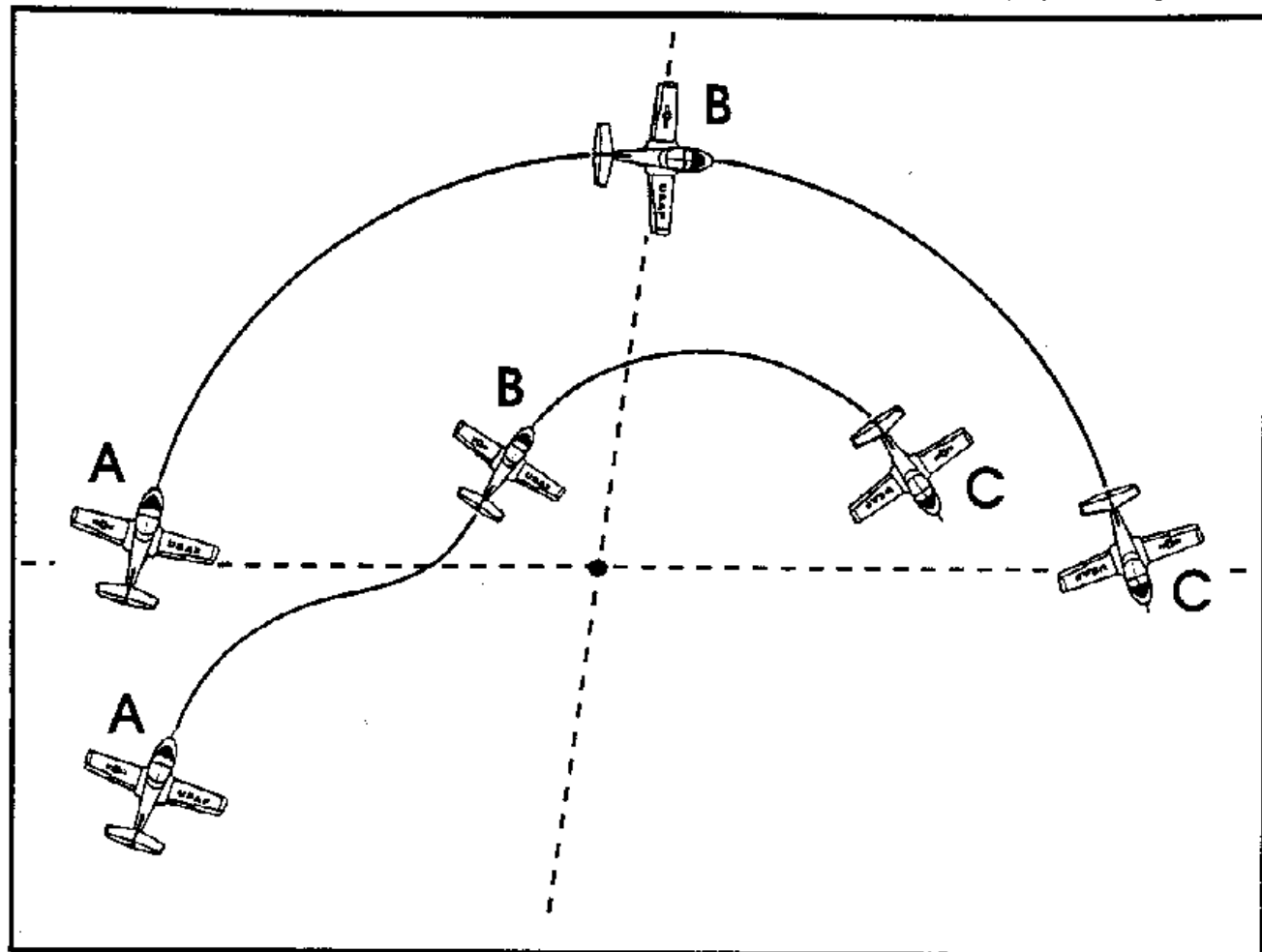
8.25.4.2.1. Lead. After the wingman calls "ready," initiate and maintain a level turn of approximately 2 Gs and 60° of bank in one direction. Maintain approximately 200 KIAS to optimize your turn radius and turn rate. An airspeed significantly slower than 200 KIAS, e.g., 150 KIAS, would result in a higher turn rate and a very small turn radius, making it too difficult for the wingman to remain behind the 3/9 line. Conversely, flying too fast

increases the turn radius and slows the turn rate, only to increase the time it takes for the wingman to complete the entry. Attempt to maintain a relatively stable platform for the wingman. This will allow the wingman an opportunity to explore pursuit curves and closure control to arrive at the offset trail position. Look for the wingman behind the wing, not at your 6 o'clock position. Monitor the wingman's aspect and closure for inadvertent 3/9 line passage. Be prepared to knock it off if there is no attempt to correct the deviation. After the wingman calls in position, you may then reverse the turn direction. Perform turns, varying the pitch and bank while maintaining positive G's to allow the wingman to solve angular problems and stay in position. These turns are flown like a lazy eight, except it is not necessary to reverse the turn on each leaf. However, never maneuver in an unpredictable or abrupt manner which may force the wingman forward of your 3/9 line. Your vertical movement to manage energy also presents difficult angle and closure problems to solve for the wingman. Always observe the wingman's aspect angle and angle off before maneuvering aggressively since the wingman may, in turn, be aggressively repositioning to counteract your current flight path. In addition, vary the pitch, bank angle, and airspeed in your turns to give your wingman challenging problems to solve while in the offset trail position. Remember, you are a training platform for your wingman and it is incumbent upon you to provide reasonable problems to solve. If you maneuver too aggressively, your wingman may not be able to achieve the desired training objectives. Once the learning objectives have been met, you may terminate the maneuver visually (slowly rocking wings) or with the knock-it-off radio call as described in paragraph 8.24. Remain predictable and then transition to a level turn for the rejoin.

8.25.4.2.2. Wingman. Your individual training objectives and roll out distance behind lead will determine your options to enter the offset trail exercise. At 1,000 feet, you will need to initiate a lead pursuit curve to close on lead. If you are farther out than 1,000 feet, you may elect to continue straight ahead for 3 to 4 seconds, or until lead aircraft is displaced approximately 30° off your heading. This delay will place you closer to lead's turn circle before starting your entry. Use military power when initially setting a lead pursuit curve and starting your low yo-yo. Placing lead several inches below the canopy bow will ensure adequate vertical spacing and prevent you from descending too low. Descending too low may cause excessive airspeed and will require a considerably high yo-yo when repositioning. Flying too high may cause visibility problems for the crewmember

looking across the cockpit and may result in less than adequate airspeed for closure and repositioning. A target airspeed of 220-240 KIAS is optimum. As you develop closure with lead pursuit, you will notice your aspect angle increasing and your range decreasing. Monitor aspect and closure early as you approach the 3/9 line. Plan to maneuver before reaching the 3/9 limit. When you see lead's tail superimposed over the outside wingtip (4 aspect), start your transition to a pure pursuit curve. Pure pursuit will prevent your aspect angle from rapidly increasing as lead continues the turn. This will help you control your closure and will not require a large repositioning maneuver. When your range approaches 600 to 700 feet, use a high yo-yo to remain aft of lead's 3/9 line. This lag maneuver will reduce both aspect and closure, allowing a wingman's turn circle to fit inside lead's turn circle (figure 8.17). A good rule of thumb is if your range is 1,000 feet prior to entry, you will need to use at least one high yo-yo. Also, if your range is 1,500 feet prior to entry, it may take two or more high yo-yo's with the first yo-yo beginning at the 900 feet range and the second at 600 feet. Vertical movement during the high yo-yo will provide turning room to realign fuselages (decrease angle off) and preserve your energy as you close within 500 feet. The high yo-yo should be flown crisply and fairly quickly to avoid excessive angle off. Attempt to stay out of lead's jetwash. Once inside 500 feet and on the 45° line, make the radio call, "Curly 2's in." Your range should never be less than 300 feet from lead or forward of lead's 3/9 line.

8.25.4.2.2.1. Once you make the radio call indicating you are in position, lead will introduce vertical maneuvering with lazy eight type maneuvers and varying G loading. Realize that as lead maneuvers, you must predict lead's flight path and maneuver in relation to lead. This will require you to analyze lead's plane of motion and turn rate before deciding which pursuit curve to fly. You will continue to use the same concepts practiced in the entry, only scaled down to much smaller movements, to remain on the 45° line. You will move continuously from lag to lead pursuit curves when lead is maneuvering as you anticipate lead's nose movement. Aspect changes can occur rapidly and you must be prepared to maneuver accordingly. For example, if lead turns into you as you are aggressively pulling lead pursuit, you may easily exceed the 45° limit. Pause momentarily to see how rapidly lead is moving, predict lead's flight-path, then maneuver. When in lag pursuit, do not allow your angle off to build excessively. Normally, you will not spend much time in a lag pursuit curve.



★Figure 8.17. Lag Maneuver into Lead's Turn Circle.

8.25.4.2.2.2. You may have to exaggerate your pursuit curves and adjust your power to remain in the offset trail position. Normally you will stay in an exaggerated pursuit curve for only a short period of time. Remain below lead's flightpath to enhance your visibility in the event that lead turns into you. From that position, a move to a lag pursuit curve is the best solution. Flying intentional lag rolls is not a desired training objective. Transitory periods in the leader's high or low 6 o'clock position while maneuvering is acceptable, but the wingman should avoid stagnating in the 6 o'clock position and concentrate instead on maintaining the 45° aspect angle. This position will challenge your knowledge of pursuit curves as well as aspect and closure awareness. When you determine you have met your learning objectives, use the knock-it-off radio call and procedures described in paragraph 8.24 to cease maneuvering.

8.25.4.2.2.3. As with other formation maneuvering, each pilot has the responsibility to take whatever action is necessary to avoid a collision.

Because of the dynamic nature of the offset trail exercise, the problems of collision avoidance are compounded and require uncompromising flight discipline. Either aircraft should use the knock-it-off radio call as described in paragraph 8.24 to cease maneuvering when any of the offset trail parameters or rules of engagement have been violated by either aircraft. This radio call should also be made when any safety of flight conflict exists.

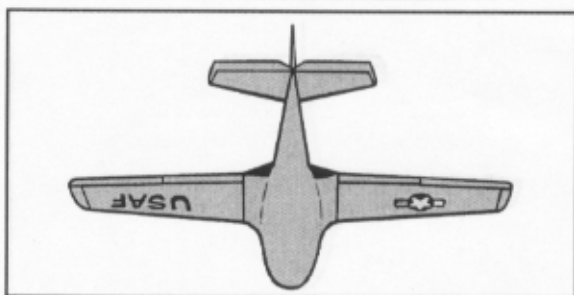
8.26. Close Trail. Close trail is flown to demonstrate flying in close proximity directly behind another aircraft. Lead may initiate the maneuver from fingertip, echelon, or route.

8.26.1. Lead. Direct the wingman to the close trail position with a radio call, "Curly, go close trail." Wait for the wingman to call in before maneuvering. Maneuver in a smooth, predictable manner and maintain positive G forces at all times. Avoid sudden releases of back pressure and rapid turn reversals. Power requirements are identical to

fingertip formation.

8.26.2. Wingman. Acknowledge the call to go close trail, maneuver to the trail position, and use the radio call, "Curly 2's in" when you are in position. The proper close trail spacing is one to two aircraft lengths (nose to tail) behind lead and just below lead's jetwash. Maintain this position primarily through the use of power. However, when lead is turning at higher G loads, you may need to use a small amount of lead pursuit to maintain position.

- ★8.26.2.1. Use the relationship between the tips of lead's horizontal tail and the underside of lead's wing as an aid in estimating nose and tail separation. At approximately two ship lengths, the tips will line up with the inside of the "U" in "USAF" on the left side and the inside of the chevron on the right side (figure 8.18). At approximately one ship length, the tips are in the middle of the "U" in "USAF" on the left side and just inside the chevron on the right side. As a vertical reference, place lead's horizontal tail at the top of the canopy bow. To prevent encountering jetwash, never fly higher than a position where you can begin to look directly into lead's exhaust nozzles. As lead maneuvers, anticipate power changes to prevent too little or too much spacing.



★Figure 8.18. Close Trail.

8.26.2.2. Closure rates are difficult to determine when directly behind lead. Therefore, if excessive spacing exists, do not attempt to move forward with power alone. Add power and establish a small amount of lead pursuit while in a turn. If you are in a wings-level attitude, move off to one side to obtain a better perspective of lead. Make a knock-it-off call if you fall significantly out of position. The two most important points to remember are to remain below lead's jetwash and always keep lead in sight.

★8.26.3. **Termination.** Close trail maneuvering may be terminated by the lead or wingman when desired learning objectives have been met. Lead will direct the formation to rejoin to fingertip with a wing rock or radio call. Lead should maneuver in a smooth, predictable manner and avoid any significant power changes until the wingman has reached the fingertip position. The wingman can direct maneuver termination by using the knock-it-off call as described in paragraph 8.24.

8.27. In-Flight Position Changes. As the wingman, before each formation flight, you are briefed on the position you will fly. Maintain the position assigned to you for the duration of the flight unless lead directs a position change. Position changes will be made with the formation in wings-level flight. To initiate the position change, lead directs the wingman to route and calls or signals for the position change. If lead uses a radio call, the wingman acknowledges the call and becomes the new lead at that time. If lead uses a visual signal, the wingman acknowledges with a head nod and becomes the new lead at that time. The position change is not complete until the wingman has acknowledged the position change. (The new wingman stays in route until rocked back into fingertip by the new lead.)

8.28. Airborne Formation Aborts. The primary reason for formation flying is mutual support. This applies to noncombat hazards too. If either member of the formation must return to the airfield prematurely, the other aircraft should normally return also and provide any assistance required. (Exceptions to this may be made by the IP if the difficulty is routine and the field is in sight or if the weather conditions would complicate a safe formation return, etc.)

8.29. Descent and Landing:

8.29.1. During the letdowns, the speed brake may be used at lead's discretion. Once established at pattern altitude for entry to the VFR pattern, all turns away from the wingman will be echelon unless briefed otherwise. Before initial approach, lead positions the wingman on the opposite wing from the direction of the break. Initial should be long enough to allow the wingman to settle down in fingertip before the break.

8.29.2. At the break point, lead should smoothly turn to the downwind and delay retarding the throttles until the turn is initiated. After lead's break, the wingman waits 5 seconds before following. Attain spacing in the break and on

downwind. On downwind, the wingman should be slightly outside lead's flightpath.

8.29.3. As the wingman, fly a normal contact pattern. Each aircraft should be able to initiate the final turn at the same point. However, do not follow a poor pattern flown by the aircraft ahead. Go around if you cannot complete a proper pattern. Each crewmember uses his or her individually assigned call sign for the gear check. In crosswinds, lead normally lands on the downwind side of the runway.

8.30. Instrument Penetration. Formation penetration procedures are the same as for a single ship with the following exceptions. At the start of the penetration, as a technique reduce power to 75 percent. As the airspeed approaches 200 knots, extend the speed brake. After level off, use the speed brake and power as required to maintain desired airspeed. Before starting the penetration, position the wingman away from the direction of the penetration turn.

8.31. Instrument Approach. Lead positions the wingman on the upwind side of the landing runway. Use a visual signal or radio call for gear and flap lowering. Transmit a gear down call either by the lead aircraft for the flight or by each aircraft in turn. Lead uses landing lights on final. Both aircraft lower flaps as appropriate for the situation. To provide the wingman with a good power response, lead normally uses full flaps. Maintain 110 knots on the approach after configuring.

8.32. Wing Landing:

8.32.1. Maintain the normal fingertip position during the approach. After definitely breaking out of the weather, but no later than 1/2 mile from the runway, the wingman will spread laterally to attain approximately 10 feet of wingtip clearance and stack level with lead. Lateral spacing will increase the wingman's margin of safety if any problems occur during touchdown and landing roll.

8.32.2. When the formation definitely breaks out of the weather and visual contact with the runway can be maintained, lead lines up with the center of one side of the runway and plans the touchdown approximately 1,000 feet down the runway.

8.32.3. As the flight approaches the overrun, the wingman should begin to cross-check the runway. Continue to fly off lead during the flare and landing, but monitor the runway and flight

parameters to ensure a safe landing. Lead gradually reduces power for the roundout. The wingman must reduce power gradually with lead to avoid falling out of position during the roundout and touchdown. Once on the runway, maintain your side of the runway and use normal braking technique regardless of lead's deceleration rate. Pass lead rather than overbrake to maintain position.

8.32.4. Initiate formation go-around, when required, as early as possible. Lead should smoothly add power to approximately 95 percent rpm and follow normal formation takeoff and go-around procedures. If clearing the runway is required, lead should confirm number two's position and ensure the wingman has safe altitude and airspeed during maneuvering.

8.33. Formation Touch-and-Go Landings. Formation touch-and-go landings may only be performed in conjunction with pilot instructor training (PIT). These landings allow multiple wing landings on a single sortie. Use extreme caution when flying formation in the overhead pattern. Throughout the landing, use the procedures covered in the wing landing section. On touchdown, lead will retract the speed brake and advance the throttles to 98 percent as in a normal formation takeoff. The primary aim of number two is to maintain good lateral separation during the takeoff. Perfect fingertip is not a requirement. The primary concern is to take off safely so another formation landing can be made. Change lead only when safely airborne with 150 knots minimum. Under normal conditions lead changes are made on outside downwind.

Section C—Three- and Four-Ship Formations

8.34. Guidelines. Three- and four-ship formation flying requires thorough planning and attention to detail from preflight through postflight. All members of the formation will be briefed and thoroughly familiar with the proposed profile and procedures. Due to T-37 engine response and proximity of aircraft, lead must use smooth throttle inputs and carefully monitor wingmen positions during power changes. The basic formation positions, references, techniques, and procedures described for two-ship formation apply to three- and four-ship formations as well. Airspeed for rejoins will normally be 190 KIAS or as briefed.

★8.35. Deleted.

★**8.36. Runway Lineup.** Figure 8.19 depicts the runway lineups for a four-ship takeoff. See AETCM 11-201 for runway width restrictions for each lineup.

8.36.1. Normally, a formation will use the element lineup depiction. Wingmen should be placed on the upwind side of the runway just like a two-ship formation. If crosswinds are not a factor, place the wingmen on the inside of the first turn out of traffic. See figure 8.20. If critical field length is not a factor, 500 feet of space between elements can also be used as an option.

8.36.2. To establish the slot lineup, lead will be as far to the side of the runway as practical. Number two will place the wingtip closest to lead on the center line. Number three will line up with 10 feet of wingtip clearance on number two, in echelon position (helmets of one and two aligned). Number four will pull in between one and two with wingtip clearance, aligning to the appropriate formation position on three. Four will pull forward enough to see three's helmet, but before it is blocked by two's rudder. Four will not run up power until one and two roll.

8.36.3. If the departure will necessitate turning rejoin, numbers three and four must join to the outside of the turn. Lead must ensure number two is on the inside of the turn for the element rejoin after safely airborne and cleaned up.

★**8.37. Runup and Takeoffs.** When all aircraft are in position, lead directs the engine runup. Use the same runup procedures as in two-ship formation. During individual takeoffs, numbers two, three, and four may delay their runup a few seconds. A three- and four-ship formation takeoff may be accomplished by single-ship takeoffs with individual rejoins out of traffic or by element takeoffs. Use 10 second (minimum) spacing between individual aircraft departures. Use 10-second (minimum) spacing between elements; however, if element departures are used due to weather, use spacing criteria as specified in local directives. Maintain fingertip until reaching VMC.

8.38. Takeoff Aborts. Each aircraft must be prepared to react to any situation if a preceding aircraft aborts. Options available are to either hold position, abort, or continue the takeoff as safety dictates.

★**8.39. Join Ups.** The type of join up will depend on the local departure procedures. It may consist of a turning rejoin, a straight ahead, or a combination of both; and it must be briefed prior

to departure. Normally, for join ups following element takeoffs, number three will send number four to a route position, with a minimum spacing of 100 feet, prior to rejoining on the lead element. Number four will fly a position off number three, but will monitor the lead element throughout the rejoin. During the rejoin, number three must avoid sudden power changes and abrupt flight control inputs. Each aircraft maintains a minimum of 100 feet of separation until the preceding aircraft has stabilized in route.

8.40. Turns (From Takeoff). Lead starts a turn and maintains briefed airspeed until the formation is joined. Wingman begins the turn no earlier than the departure end of the runway. Each aircraft individually joins in the turn. If the rejoin is delayed, formation lead may roll out and call for a straight-ahead join up. Each formation member plans the turn to cut off and intercept lead during the turn out of traffic. The join up should be readily accomplished unless a formation member delayed takeoff, did not use enough cutoff angle, or failed to use sufficient power and (or) airspeed advantage to complete the join up.

8.41. Straight Ahead (From Takeoff). Lead maintains straight flight and briefed airspeed until the formation is joined.

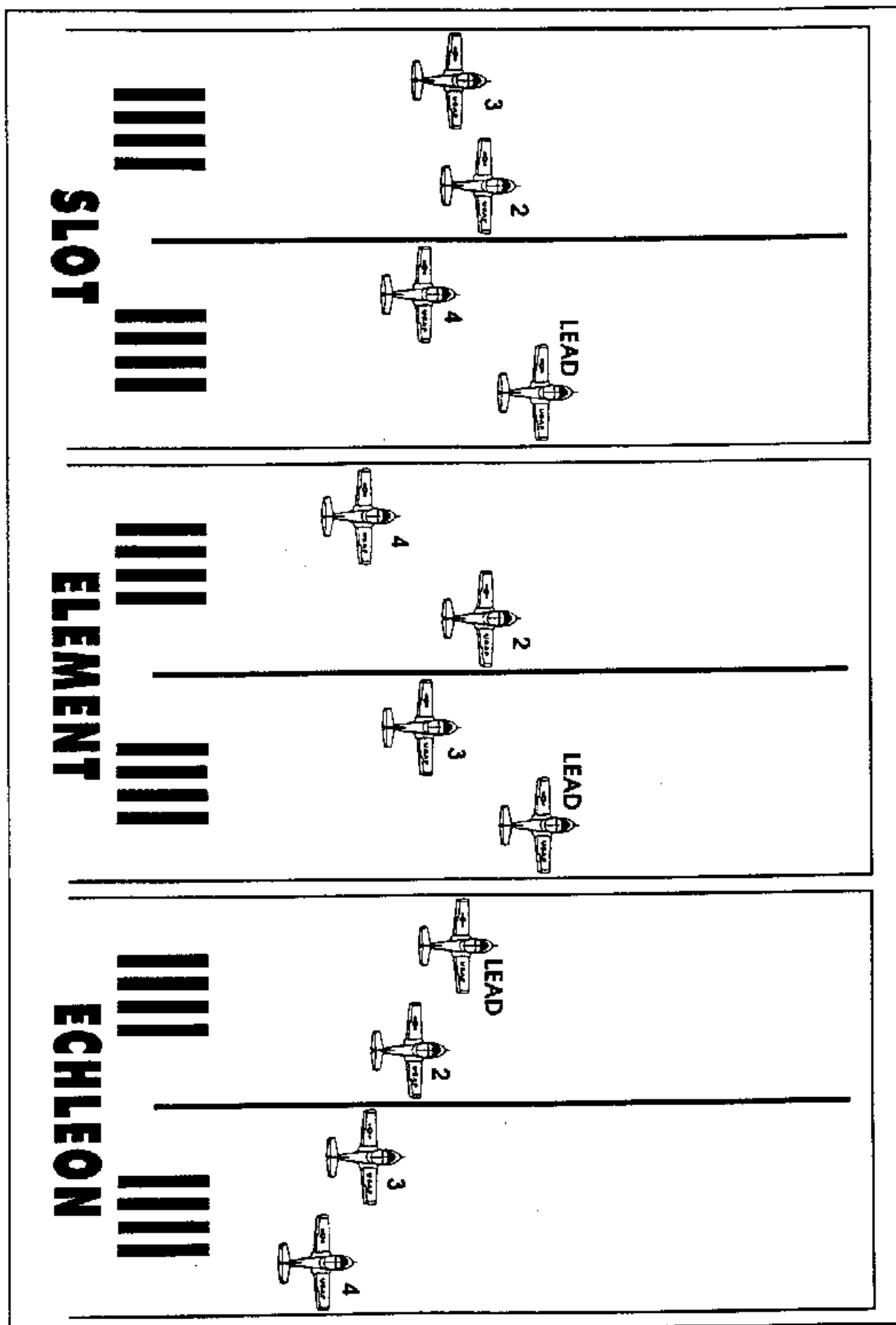
8.42. Formation Positions. The following positions are approached primarily from the wingman's point of view:

★**8.42.1. Fingertip.** Number four's position should be determined, using the normal fingertip references relative to the number three aircraft. If number three is rough, number four should fly a stable position on lead and constantly monitor number three's position (figures 8.21 and 8.22).

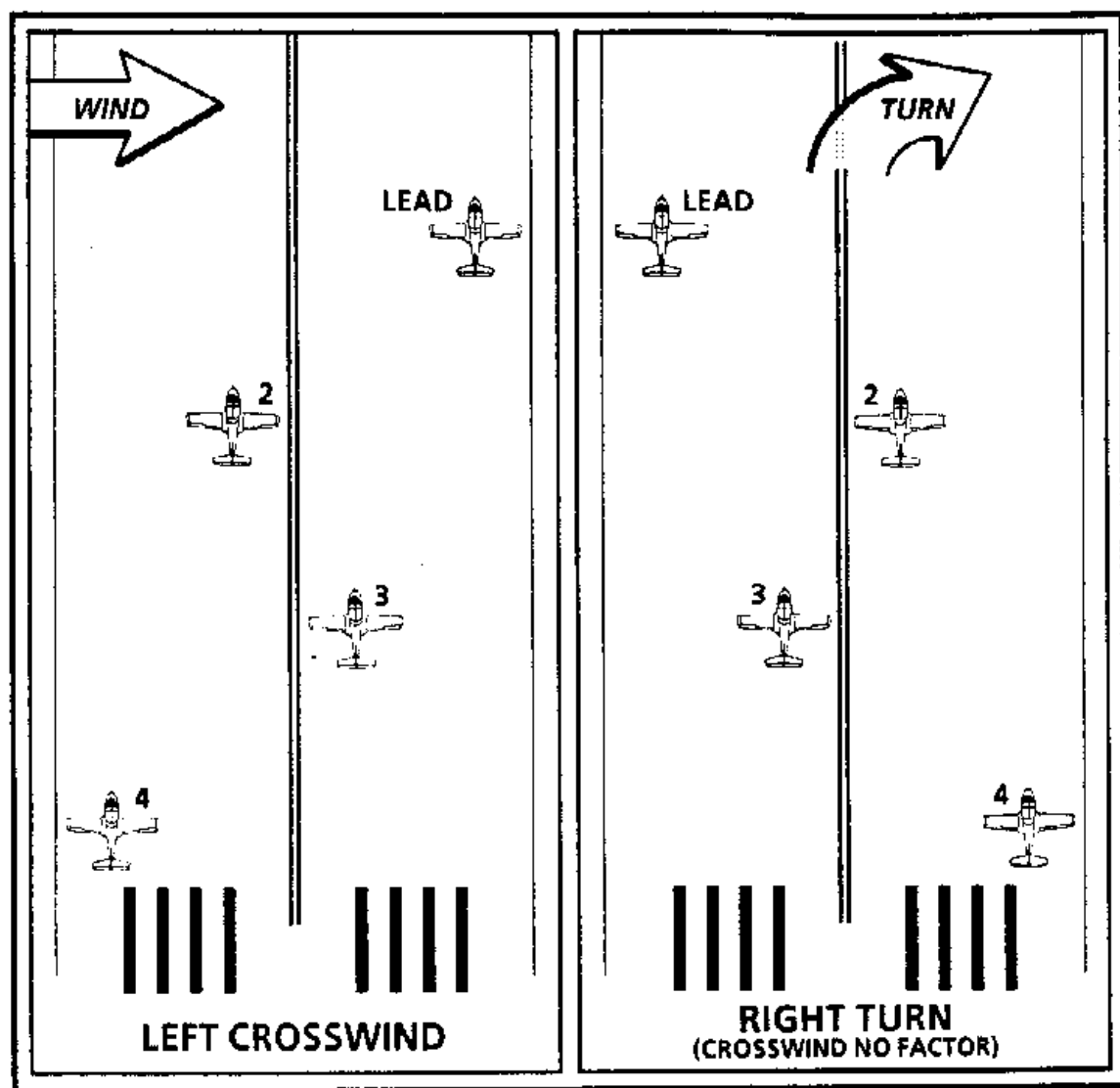
★**8.42.2. Echelon.** Echelon is a variation of fingertip formation in which the second element aligns itself on the same side as number two or vice versa (figures 8.23 and 8.24).

★**8.42.2.1.** Lead signals for echelon by dipping a wing in the desired direction. If lead's wing dips toward number two, number two holds position. Number three and four move back and down to provide adequate clearance from the lead element. Number three (with number four on the wing) then begins to cross to an echelon position on the wing of number two, keeping safe clearances. As number three crosses behind lead, number four crosses under to the new position on the other wing of number three (figure 8.25).

★**8.42.2.2.** If the echelon signal is given toward the



★Figure 8.19. Four-Ship Runway Lineup.



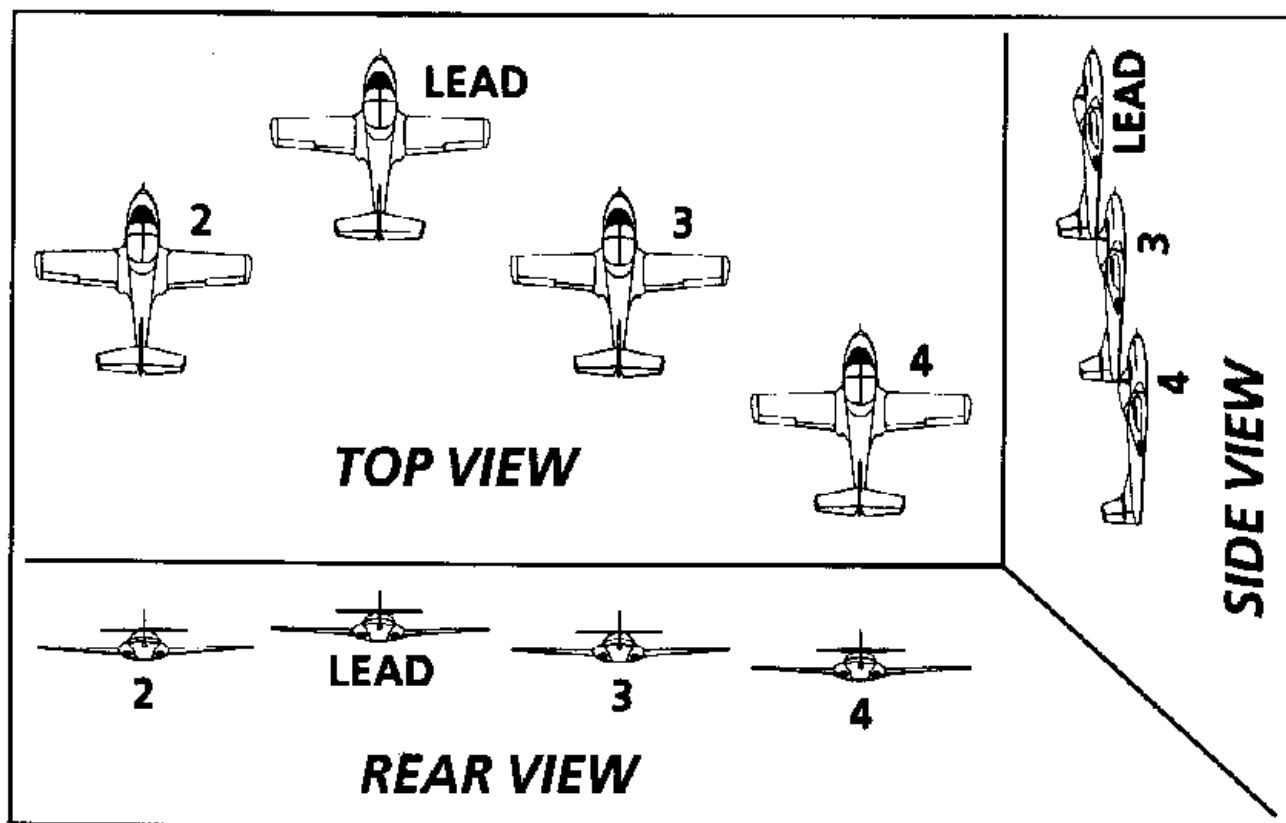
★Figure 8.20. Four-Ship Element Lineup for Crosswinds.

side of the second element, number three (with number four on number three's wing) moves out and back and slightly down to make room for number two. Number two maintains position until the element has spread out. Once number two has determined the second element has made sufficient room, number two executes a normal crossunder. Keep the element in sight until moving forward on lead. Numbers three and four align themselves with number two and lead. Smooth technique by numbers two and three will prevent a crack-the-whip on number four (figure 8.26). Except for very gentle turns into the echelon, turns are always made away from the echelon. Number three flies off of number two; and number four flies off of number three, using normal echelon references.

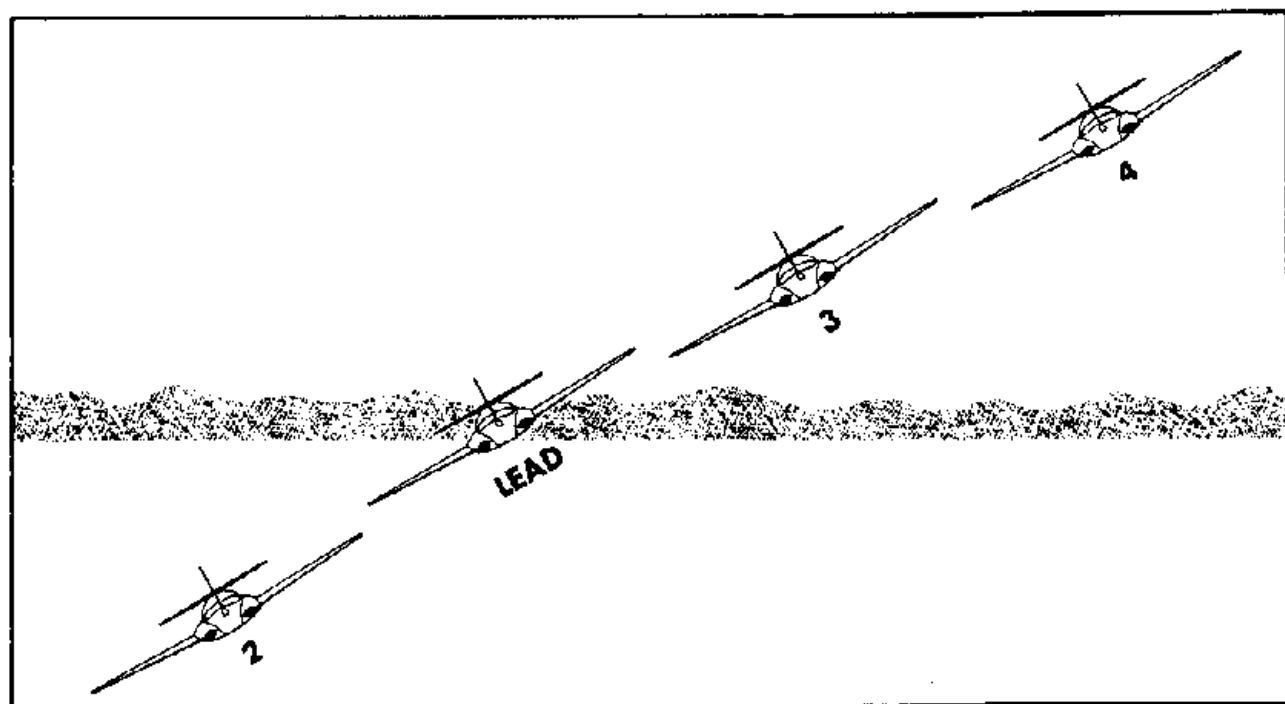
8.42.2.3. Lead of a three-ship formation signals

for echelon by using the same procedures as in four-ship formation; that is, by dipping a wing in the desired direction of echelon. In three-ship echelon, turns must be directed by radio call ("Curly, right turn"). If an echelon turn is not directed, numbers two and three will maintain fingertip references. Lead will direct the formation back to the fingertip position with a radio call. An aircraft or element that crossed under to form the echelon will return to the original position by executing another crossunder.

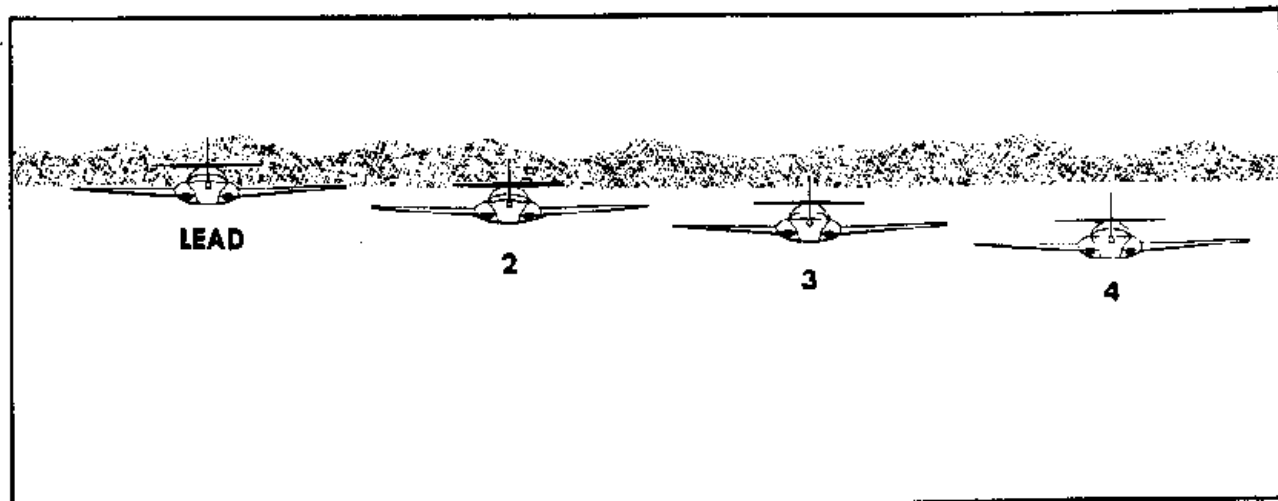
8.43. Route. The purpose and parameters of a four-ship route are the same as for a two-ship route. Due to the decreased maneuverability of a four-ship route, wingman should favor the extended fingertip line in level flight and may maneuver behind the line to maintain spacing and sight of



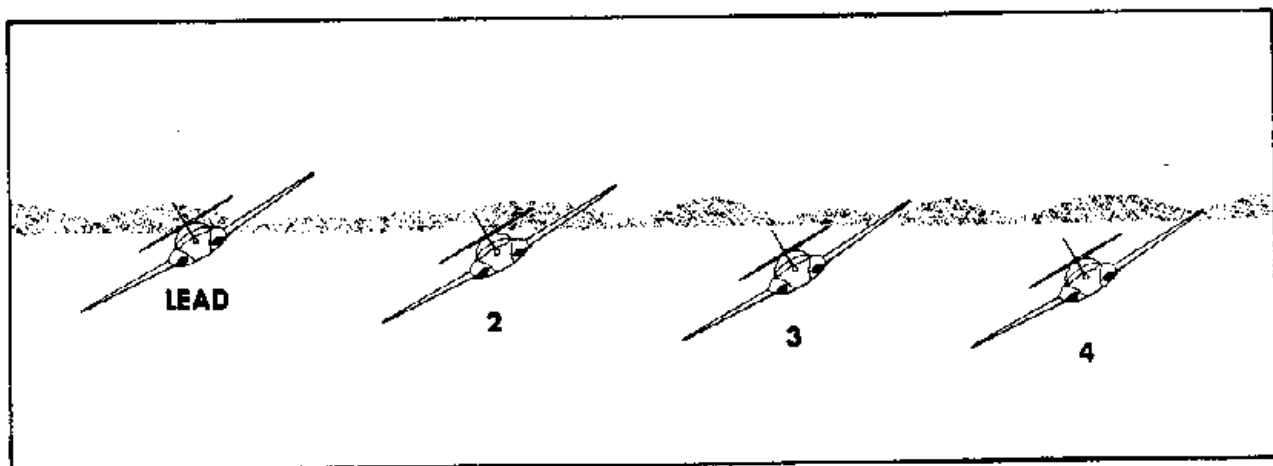
★Figure 8.21. Four-Ship Fingertip Formation.



★Figure 8.22. Four-Ship Fingertip Formation in a Turn.



★Figure 8.23. Four-Ship Echelon.



★Figure 8.24. Four-Ship Echelon Turn.

lead. Flight lead may brief more specific parameters for each mission, based on anticipated weather, profile requirements, and (or) experience level.

8.44. Rejoins:

8.44.1. Turning Rejoins:

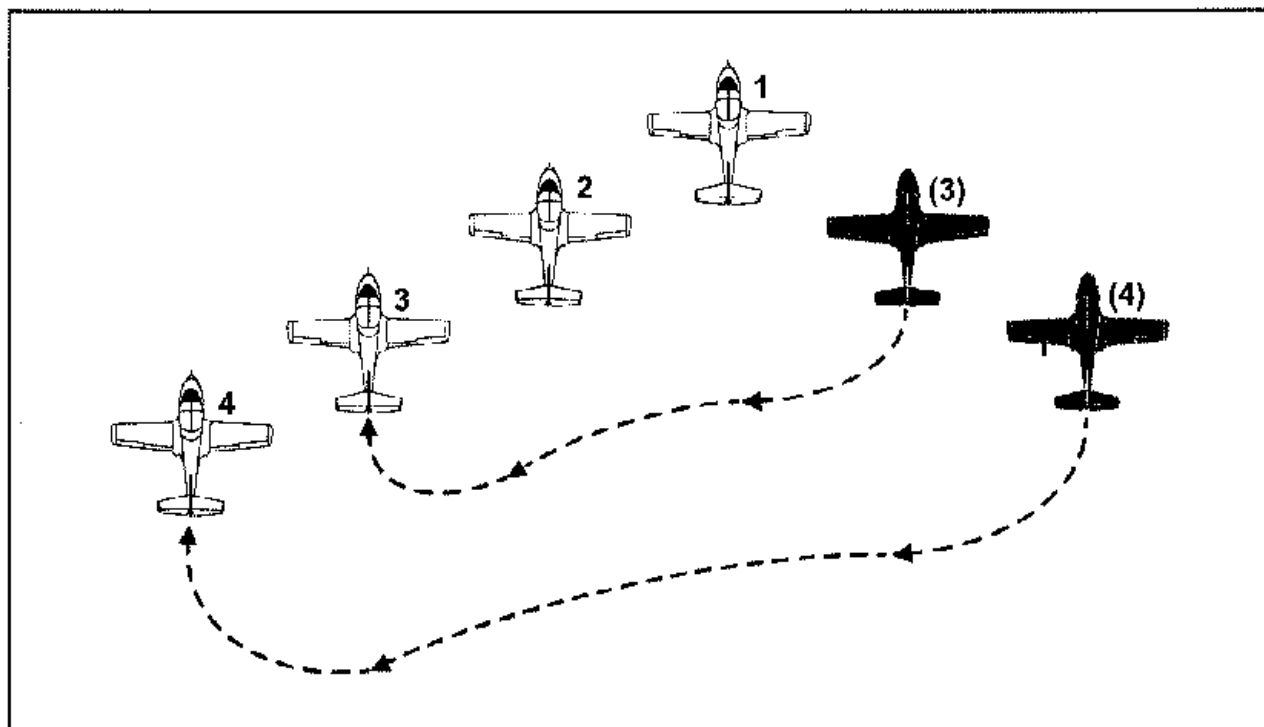
8.44.1.1. During four-ship turning rejoins, wingmen will relay the wing rocking signal to the aircraft behind them. Number two always joins to the inside of lead's turn. Rejoin procedures for number two are identical to the procedures described in the two-ship section. If number two is slow to rejoin, it will complicate the rejoin for numbers three and four. They will have to decrease airspeed and (or) cutoff to maintain proper spacing on the preceding aircraft.

8.44.1.2. Number three will always join to the outside of lead's turn. The basic rejoin techniques

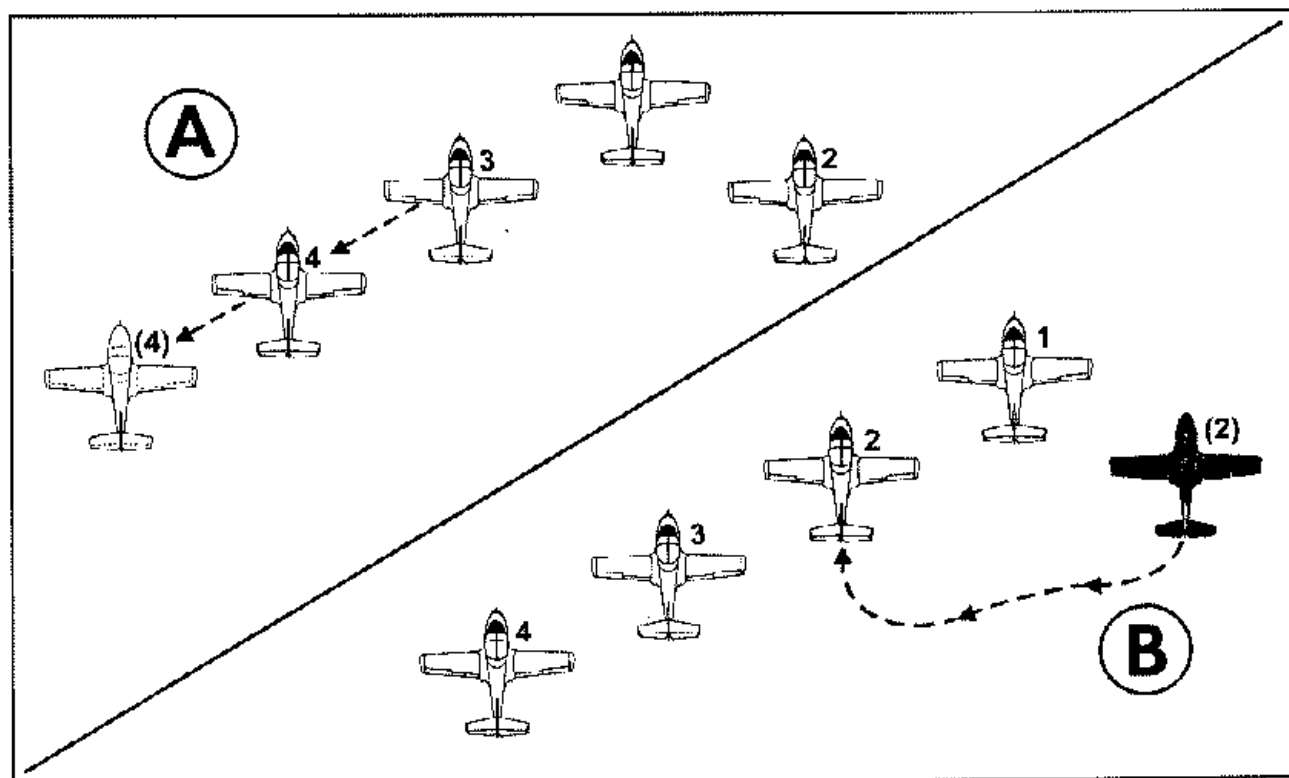
used by number three are the same as those used by number two; however, number three has the additional responsibility of monitoring number two and remaining aware of number four.

8.44.1.3. Number three should establish a normal cutoff angle on lead no greater than the angle used by number two. Accelerate to gain an airspeed advantage on lead. Maintain a 100-foot clearance (minimum) on the lead element until number two is stabilized in route.

8.44.1.4. Number three should plan the rejoin to pass at least two ship lengths behind and below the first element as he or she moves to the outside of the turn. Stabilize in route and slowly move into fingertip position on lead. Avoid abrupt control pressure and rapid throttle movements if number four has closed to minimum distance (approximately 100 feet).



★Figure 8.25. Echelon Crossunder, Numbers Three and Four.



★Figure 8.26. Echelon Crossunder, Number Two.

8.44.1.5. Number four will also always join to the outside of lead's turn. Basic rejoin techniques still apply. However, number four must monitor number three as well as the lead element during rejoin. After receiving the rejoin signal, number four begins a turn to establish a cutoff angle no greater than number three or number two, while accelerating to gain an airspeed advantage. Monitor all aircraft in the formation as the rejoin progresses. As number four, maintain this cutoff angle on the lead element and number three. Plan your rejoin to pass at least two ship lengths behind and below the first element and number three as you move to the outside of the turn. Stabilize in route, and slowly move into fingertip position on number three.

8.44.1.6. If number three is slow to rejoin, number four should maintain at least a 100-foot clearance on number three. This is a fluid position because number four must use a combination of trail and rejoin techniques while monitoring both number three and the lead element. When number three has stabilized in route on lead's outside wing, number four is cleared to join on three's outside wing.

8.44.2. Straight-Ahead Rejoins. After completing the pitchout, lead signals for a rejoin by rocking the wings or making a radio call. The call will identify the side to which number two rejoins. The second element always joins to the side opposite number two. If rejoin airspeed is other than prebriefed, lead announces the airspeed he or she will hold for the rejoin. Wingmen will pass along the wing rocking signal to the aircraft behind them. Number three will turn slightly to join on the side opposite number two. Clearances, techniques, and procedures are the same as used by number two. After receiving the rejoin signal and (or) radio call, number four joins on number three on the side opposite the lead element and maintains a minimum of 100-foot clearance on number three until number three begins closing to fingertip on lead.

8.45. Overshoot. As a member of a four-ship formation, you must recognize an overshoot situation as soon as possible and make positive corrections. Use power and (or) speed brake to control excessive closure rates during rejoins. Element leads will notify wingmen by radio if speed brakes are to be used ("Curly 3, speed brake"). This will alert a wingman who has already moved to a position of a 100-foot clearance that speed brakes are being used.

8.45.1. If an overshoot is appropriate, follow

established procedures. Do not go belly up to lead in an effort to prevent an overshoot. Stay low enough to keep the aircraft ahead of you in sight at all times. Go to the outside of the turn with at least a two ship-length, nose-to-tail clearance behind the aircraft ahead. Use speed brakes and power as necessary.

8.45.2. Once outside the turn, position yourself vertically no higher on lead than the echelon turn reference. The greater your overtake speed on the overshoot, the wider you must go to prevent passing lead. As soon as you see you are on or dropping back through the echelon turn references:

8.45.2.1. As number two, clear to ensure sufficient spacing on number three before returning to the inside of the turn, reestablish yourself on the join-up line, and complete the rejoin.

8.45.2.2. As number three, if number two overshoots, modify your rejoin by decreasing your airspeed and cutoff to ensure adequate clearance as number two returns to the inside of lead's turn.

8.45.2.3. As number four, follow number three whether number three is overshooting or adjusting for a number two overshoot. If number three is overshooting, use good judgment and a combination of trail and rejoin techniques to stay with number three. Maintain a 100-foot clearance (minimum) until number three is in route.

8.45.3. When executing an overshoot as number three or four, use the same procedures as described for a number two overshoot. However, when stabilized on the outside of the turn, you must determine whether it is more appropriate to remain on the outside of the turn or return to the inside to complete the rejoin.

8.46. Three-Ship Formation. Three-ship formation is usually the result of a ground or takeoff abort. Lead will ensure aircraft in the flight are renumbered. In three-ship formation, rejoins are practiced to the normal positions (number two to the inside and number three to the outside). If practice joining both aircraft to the outside of the turn is desired, lead will direct both aircraft to join to the outside. For straight-ahead rejoins, lead may direct both aircraft to join to the same side. When rejoining in this manner, use procedures as described in four-ship rejoins for numbers three and four.

8.47. Leaving Formation (Breaking Out). Leaving formation is the same in three- and four-ship formation as in two-ship formation, with the following exceptions:

8.47.1. If number two or four breaks out of fingertip formation, the remaining aircraft maintain their original positions on lead. If number three leaves formation, number four follows number three at a safe distance to maintain element integrity.

8.47.2. When it is confirmed that a member has left the formation, lead directs the rejoin to the desired formation. An aircraft that has left formation does not rejoin until lead gives permission by radio call and the call has been acknowledged.

8.48. Speed Brakes. Speed brakes are lowered or raised on verbal signal by lead, or element lead, if required. Visual signals are generally not used in four-ship formations. Do not raise or lower the speed brake when the formation is in an echelon turn.

★8.49. In-Flight Position Changes. Three- and four-ship position changes are made from route fingertip or route echelon. Procedures to be used must be thoroughly reviewed in the formation briefing. The most commonly used method is for lead to direct the formation to go to route with the radio call, "Curly, go route." The wingmen acknowledge and move to route. After the formation is stable in the route position, lead will call for the position change, "Curly, position change." The wingmen will acknowledge. The old lead retains lead responsibility until the position change is acknowledged by all wingmen. The new lead will confirm

the new formation positions with a radio call, "Curly, check," before reforming the formation to fingertip and beginning other maneuvers.

8.49.1. Four-ship position changes:

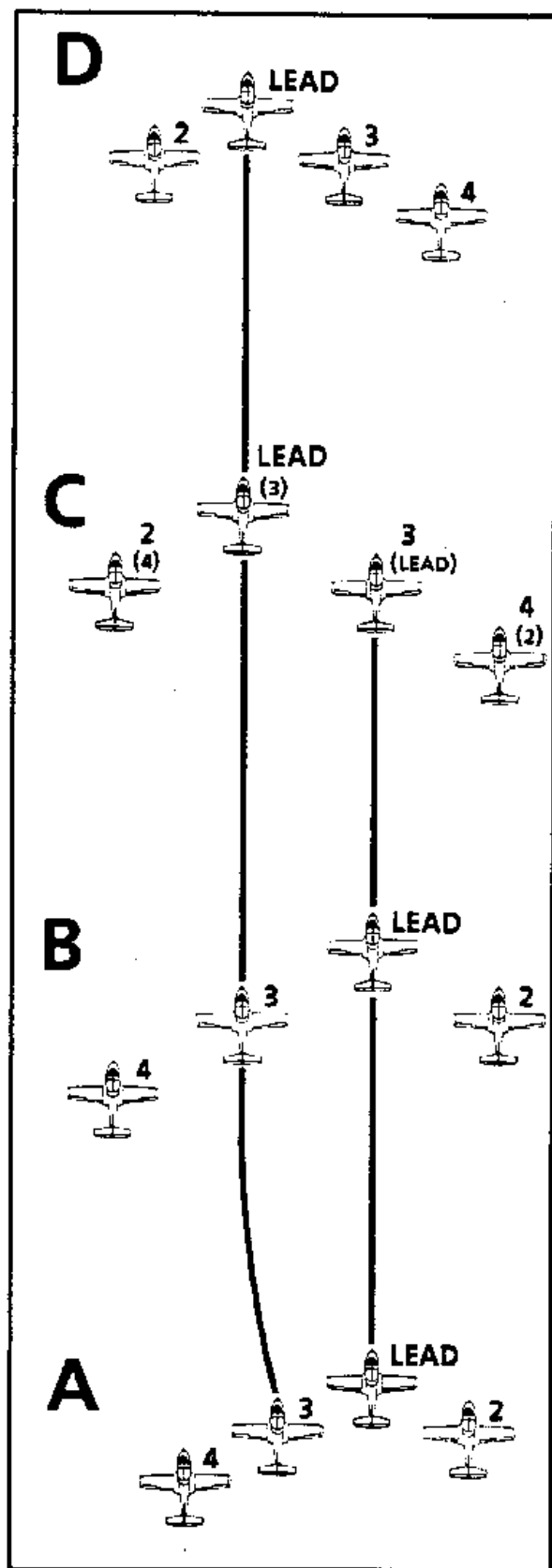
8.49.1.1. During position changes from route fingertip, number three always becomes new lead, number four becomes number two, lead becomes number three, and number two becomes number four (figure 8.27).

8.49.1.2. During position changes from route echelon, the original lead either becomes number two or number four, as briefed. When the original lead becomes number two, the original number two becomes lead and numbers three and four keep their previous positions (figure 8.28). When the original lead becomes number four, number two becomes lead, number three becomes number two, and number four becomes number three (figure 8.29).

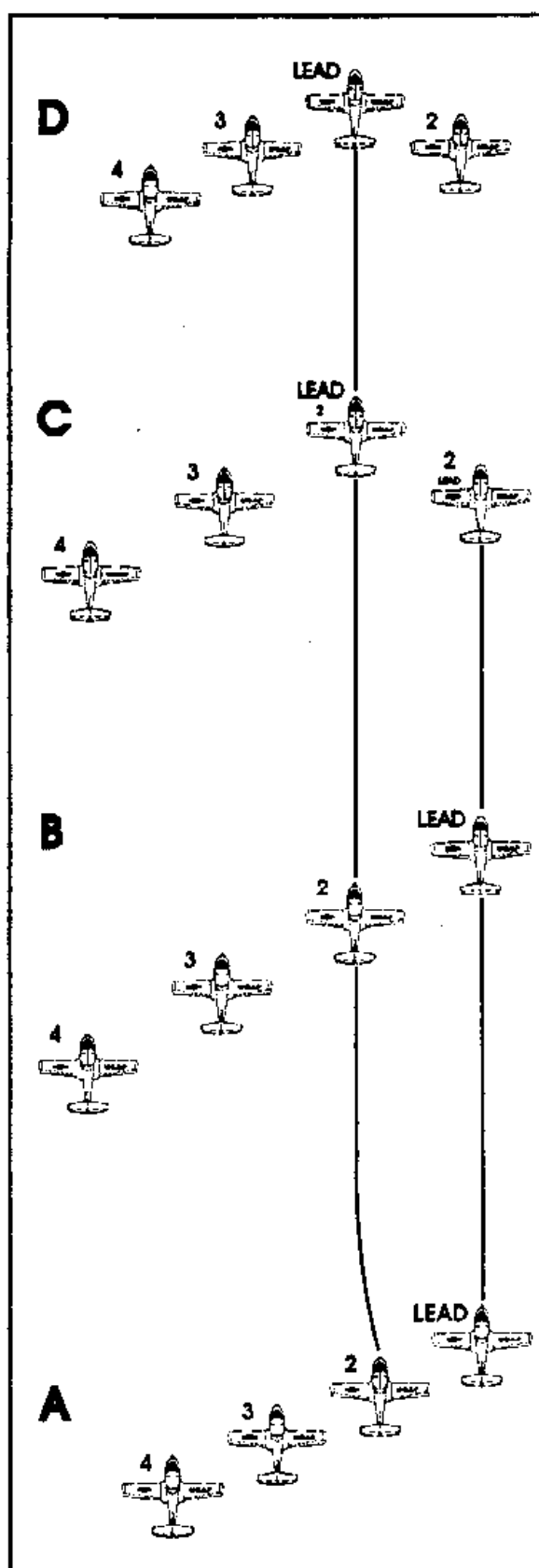
8.49.2. Three-ship position changes:

8.49.2.1. During position changes from route fingertip, lead becomes number two, number two becomes number three, and number three becomes lead. The new number two moves back with the new number three into echelon position (figure 8.30).

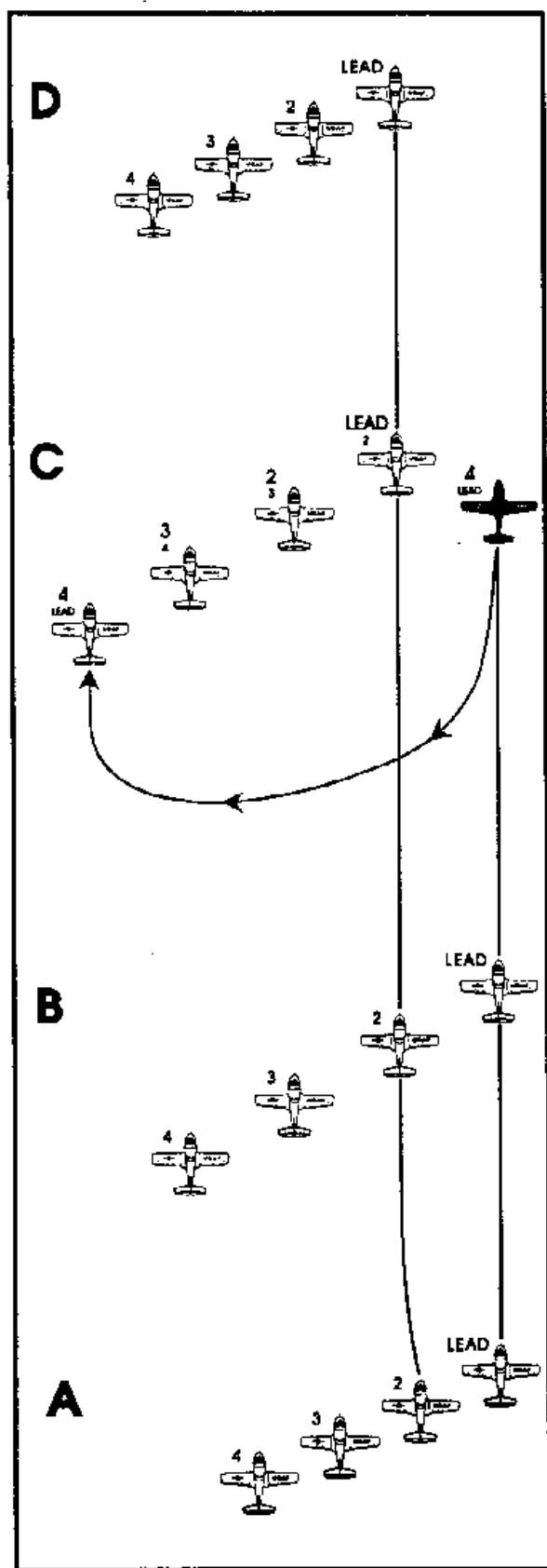
8.49.2.2. During position changes from route echelon, the original lead either drops back to the route fingertip number two position or drops back and crosses behind the flight to the number three position.



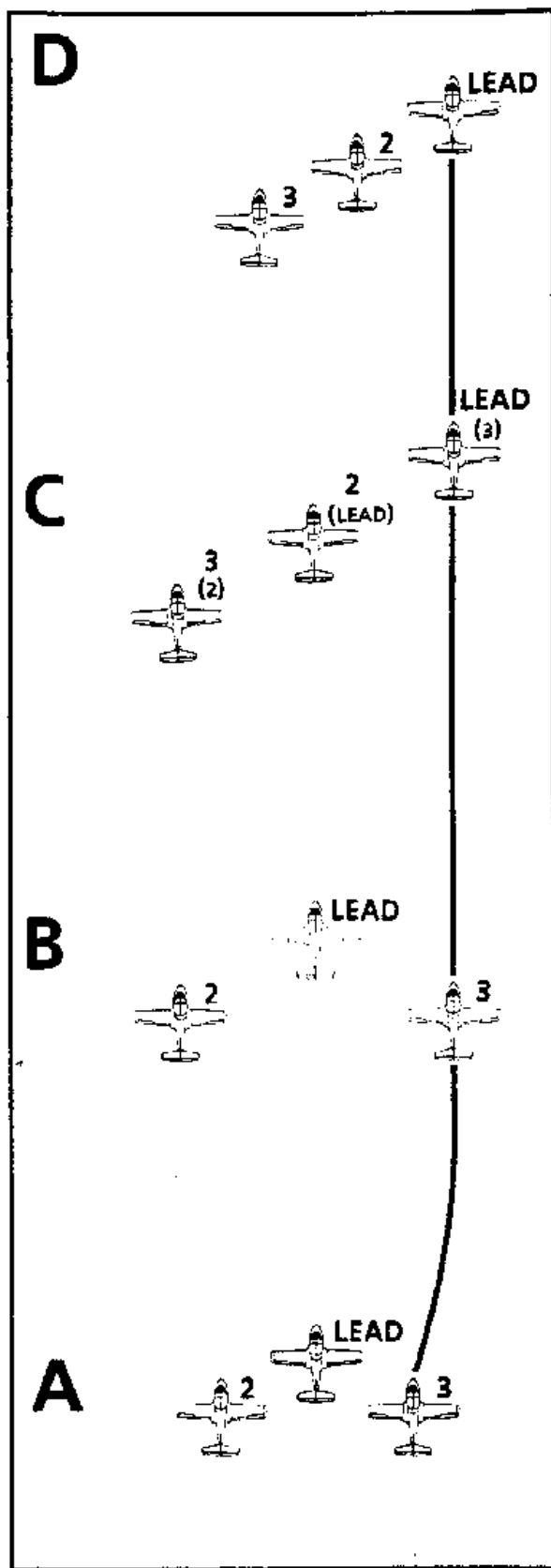
★Figure 8.27. Route Fingertip Position Change, Four Ship.



★Figure 8.28. Route Echelon Position Change, Four Ship (Lead to # Two).



★Figure 8.29. Route Echelon Position Change, Four Ship (Lead to # Four).



★Figure 8.30. Route Fingertip Position Change, Three Ship.

gentle lazy-eight-type maneuvers while maintaining your airspeed between 150 and 230 KIAS and limiting your pitch changes to $\pm 20^\circ$. Reverse your turn as necessary for area orientation and to enhance the wingman's training, but never maneuver in an unpredictable or abrupt manner. Likewise, never maneuver to intentionally force the wingman forward of your 3-9 line. As with the nonmaneuvering setup, remain aware of the wingman's position. Never reverse your turn without visual sight of the wingman.

8.54.2. Wingman. Use the same basic principles and techniques discussed under the nonmaneuvering setup. Realize that as lead maneuvers and reverses the direction of turn, you must anticipate the need for corrections. You may have to exaggerate your repositioning maneuvers in order to remain in the fluid maneuvering envelope.

8.55. Maintaining Sight of the Wingman. As lead you need to turn your body around to keep sight of your wingman as much as possible while still flying the set parameters. Momentary lost-sight situations will occur. During the maneuver entry, lead may lose sight of the wingman. Lead should look between the 0° and 45° aspect lines to reacquire the wingman. If lead cannot reacquire sight of the wingman, follow the lost-sight procedures in paragraph 8.23.

8.56. Collision Avoidance. As with all other formation maneuvering, each crewmember has the responsibility to take whatever action is necessary to avoid a collision. Because the nature of the fluid maneuvering exercise is dynamic with ever-changing aspect angles, angles off, and closure rates, the problem of collision avoidance is compounded and requires uncompromising flight discipline.

Chapter 9

INSTRUMENT FLYING

9.1. Instrument Takeoff (ITO) and Climb. The ITO is taught so you will attain proficiency in takeoff without total reliance on references outside the cockpit. With practice, you will be able to transition smoothly and safely from outside visual references to instruments if you encounter restricted visibility during or shortly after takeoff. It is rarely necessary to make a takeoff using instruments only. Even during low visibility conditions, visual references such as runway lights, center line, or runway edges are usually visible. During an actual ITO, the visual references used will become a part of the instrument cross-check.

9.1.1. Perform an ITO in a definite sequence. Learning the procedures well before flight will allow you to devote more attention to the cross-check and aircraft control. Perform the lineup check from the T-37 flight crew checklist. Adjust the attitude indicator so the miniature aircraft is superimposed on the horizon bar. Maintain runway alignment with nosewheel steering until the computed nosewheel lift off airspeed. As you rotate at this speed, release the nosewheel steering and maintain runway alignment with rudder and ailerons. Establish a takeoff attitude, using outside and instrument indications. Raise the pitch attitude on the attitude indicator approximately 5° and continue to maintain a constant heading.

9.1.2. When the aircraft leaves the ground, control the pitch-and-bank attitude, using outside references and the attitude indicator. When the altimeter and VVI indicate a positive climb indication and at a minimum of 100 knots, call gear clear and retract the gear. When the gear handle is up and you have a minimum of 110 knots, retract the flaps.

9.1.3. Maintain wings level and a 5° nose-high indication to establish a definite rate of climb. Trim to relieve stick pressures, and cross-check the altimeter and VVI for climbing indications. Maintain this attitude until you reach climb airspeed (180 knots to 10,000 feet and 160 knots above 10,000 feet). Nonstandard climb gradients on published departures may require you to adjust these procedures. If flying multiple instrument approaches, use 160 knots for the climb after takeoff.

9.1.4. The rate at which you transition entirely to instruments will depend on the rate at which you lose outside references. Make the first turn on an instrument departure procedure at a safe airspeed

and a minimum of 400 feet above the aerodrome elevation unless otherwise directed. Use a maximum bank angle of 30°. Additional information on performing the ITO is in chapter 8 of AFM 51-37.

9.2. Level Off. If an IFR departure necessitates leveling off at an intermediate altitude before continuing the climb to final altitude, level off at and maintain tech order airspeed for that altitude. Level off at cruising altitude at the airspeed specified by your instructor. To level off at an airspeed below tech order, lower the nose to level flight and retard the throttles sufficiently to reduce the airspeed. The magnitude of the airspeed change will determine your power setting. As you approach the desired airspeed, adjust power as necessary to maintain it. To level off at an airspeed higher than climb speed, leave power at military until approaching the desired airspeed, and then reduce the throttles to the power setting that will maintain it. The magnitude of any power change will determine the lead point for advancing or retarding the throttles.

9.3. Turns and Turns to Headings. In jet aircraft, it is possible but impractical to maintain a constant rate of turn using the turn needle. This is especially true at higher altitudes and under instrument conditions in turbulence. Use the turn needle only in an emergency; use the attitude indicator for bank control in all turns.

9.3.1. Normal Turns. For a normal turn, use 30° of bank.

9.3.1.1. Enter a turn by applying steady coordinated pressure on the aileron and rudder in the direction of the turn. Refer to the attitude indicator to control bank. In level turns, maintain a constant altitude and airspeed by cross-checking the attitude indicator and performance instruments.

9.3.1.2. Increase the pitch attitude as necessary to counteract the loss of lift when the aircraft is banked. Apply corrective pressures only when the flight instruments indicate deviations. The cross-check is basically the same as that used for straight-and-level flight.

9.3.1.3. When the desired level of bank is reached, it may be necessary to exert slight aileron pressure in the opposite direction. This prevents the bank from increasing beyond the desired amount. Maintain an exact angle of bank.

9.3.1.4. Adjust the power to hold a constant airspeed. As the bank is established, a small increase in power is usually required.

9.3.1.5. Reverse these procedures to return to straight-and-level flight. As the miniature aircraft on the attitude indicator approaches wings level, resume a normal flight cross-check and return the power to the level flight rpm.

9.3.2. Turns to Headings. Enter a normal turn with smooth and coordinated control pressures. Start the rollout before reaching the desired heading because the aircraft will continue to turn as long as the wings are banked. Pilot technique determines the lead point on the heading indicator. As a starting point and guide, use one-third the angle of bank as the number of degrees to lead the desired rollout heading. Develop a consistent roll-in and rollout rate. Make no attempt to play the rollout. If you miss your heading after rollout, change the lead point until you determine the proper amount needed. If the number of degrees to be turned is less than 30°, the angle of bank should not exceed the number of degrees to be turned. If the number of degrees to be turned exceeds 30°, use a 30° bank. Precise turns to headings are required in actual instrument flight. The success of an actual instrument approach depends on turning to and maintaining specified headings.

9.4. Steep Turns. A turn with greater than 30° angle of bank is seldom advisable when flying on instruments. Practice steep turns at 45° or 60° of bank at both normal and high cruise airspeed.

9.4.1. Enter a steep turn by applying steady, coordinated control pressures in the direction of the turn. The attitude indicator is the pitch and bank control instrument. Use the tachometers to control airspeed. The performance instruments will indicate the need for corrections.

9.4.2. It is more difficult to control the pitch attitude in steep turns because of the greater loss in vertical lift with the increased bank angle. There is a tendency to lose altitude in steep turns so take corrective action as soon as you detect the need. Remember, the fuselage of the miniature aircraft must be kept slightly above the straight-and-level position. After making the attitude change, check the altimeter and VVI to determine whether the correction was adequate. The effects of precession and G forces on some attitude indicators in a steep turn add to the difficulty of maintaining the desired attitude.

9.4.3. The maximum precession usually occurs after 180° of turn. You can minimize G forces

if you don't allow the vertical velocity to go below zero. Don't arbitrarily put in a correction before the need arises, but do anticipate the changes in pitch. Since any back stick pressure involves an increase in the AOA, the drag increases and the airspeed decreases. The tendency is noticeable in normal turns, but increases markedly as the bank increases. Therefore, as you enter the steep turn, anticipate the addition of power to maintain a constant airspeed.

9.4.4. Use a constant angle of bank during steep turns. Correct altitude by adjusting the pitch attitude. However, if losing or gaining excessive altitude, make a corresponding decrease or increase in bank to help correct the pitch attitude. With practice, you will learn to do steep turns without varying the bank.

9.4.5. Power control is much more critical in a steep turn than a normal turn. Because of the back pressure required to counteract the loss of vertical lift, the airspeed will dissipate more rapidly than normal as you enter the steep turn. It will also build more rapidly as you roll out. Return to straight-and-level flight smoothly using normal rate of rollout. The vertical lift will increase during the rollout, and the aircraft will tend to climb. Make pitch corrections as soon as they are needed. Readjust the power to maintain airspeed. A reduction of power is necessary as soon as you initiate rollout.

9.5. Airspeed Changes:

9.5.1. Establishing and Maintaining Airspeed. To establish and maintain an airspeed, refer to the airspeed indicator and adjust the power or aircraft attitude. A knowledge of the approximate power required to establish a desired airspeed will aid in making power adjustments. After you establish the approximate power setting, cross-check the airspeed indicator to see if you need additional power adjustments. Make it a point to learn the approximate power settings for various airspeeds and configurations throughout a normal mission.

9.5.1.1. When you observe an airspeed deviation, correct as necessary with power and pitch. For example, if you are below the desired altitude and fast, a pitch adjustment may correct both the airspeed and the altitude. Conversely, a pitch adjustment made at a desired airspeed will induce the need for a power adjustment. This is more noticeable at slow airspeeds.

9.5.1.2. To change airspeed in straight-and-level flight, adjust the power and (or) speed brake. To increase airspeed, advance the power beyond the

setting required to maintain the new airspeed. As airspeed increases, the aircraft gains lift and will have a tendency to climb. Adjust the pitch attitude to maintain altitude. When the airspeed approaches the desired indication, reduce the power to an estimated setting that will maintain the new airspeed.

9.5.1.3. To reduce airspeed, retard the power below the setting for the new airspeed. As the airspeed decreases, the aircraft loses lift and will have a tendency to descend. Adjust the pitch attitude to maintain altitude. When the airspeed approaches the desired indication, advance the power to an estimated setting that will maintain the new airspeed. You may use the speed brake for large or rapid airspeed reductions. It is best to reduce the power to the estimated setting and then extend the speed brake. Approaching the new airspeed, retract the speed brake and adjust the power if required.

9.5.1.4. Airspeed changes require a rapid cross-check and good pitch control. Referring to the attitude indicator, altimeter, and VVI and using trim during these changes will aid in controlling the aircraft attitude.

9.5.2. **Change of Airspeed in Turns.** The procedures for making a change of airspeed in turns are the same as for airspeed changes in straight-and-level flight. Airspeed changes in turns are taught to speed up your cross-check and improve your aircraft control. Your instructor may vary the amount of turn to give you practice in rolling out before, after, and as you reach your target airspeed. The use of trim is very important during airspeed changes. Along with your cross-check, trim will aid in maintaining altitude while you adjust airspeed.

9.6. **Constant Airspeed Climbs and Descents.** Many instrument flight procedures require constant airspeed climbs and descents. Perform climbs and descents at low, normal, or high cruise. If a change in airspeed is necessary, you should normally make the change before starting the maneuver.

9.6.1. Constant Airspeed Climbs:

9.6.1.1. To enter the climb, simultaneously increase the power and adjust the pitch on the attitude indicator to maintain the desired airspeed. Only a slight amount of back pressure is necessary to change from level flight to a climbing attitude.

9.6.1.2. Once you establish the climb, your instructor may have you change the pitch attitude so the airspeed is 2 to 5 knots low. You will note

a definite change on the VVI. Use this knowledge as an aid to maintain a constant airspeed. To regain 2 knots, adjust pitch to change the vertical velocity by approximately 100 fpm (or by 200 fpm to regain 5 knots). In climbs, as in level flight, use the VVI as an aid in pitch control.

9.6.1.3. To make a level off at a predetermined altitude, refer to the altimeter for a lead point. A technique for determining the amount of lead to use on level offs (climbs and descents) is 10 percent of the vertical velocity indication. As you start the level off, reduce the pitch attitude by reference to the attitude indicator and adjust power to maintain airspeed.

9.6.1.4. To attain level-flight attitude, cross-check the altimeter and VVI to determine if the pitch attitude is approximately correct for level flight. Use power as necessary to maintain airspeed, and adjust pitch to maintain altitude. It may be necessary to trim slightly during and after the level off.

9.6.2. Constant Airspeed Descents:

9.6.2.1. To enter the descent, reduce the power and adjust the pitch attitude on the attitude indicator. The amount of pitch change will vary with airspeed and power setting. Maintain the desired airspeed during the entry. Use the VVI as an aid in maintaining airspeed as previously stated in constant airspeed climbs. Use the speed brake to expedite a constant airspeed descent. This will require larger pitch changes.

9.6.2.2. To level off, retract the speed brake, if extended, adjust the pitch attitude for level flight, and simultaneously adjust the power to maintain the desired airspeed. Do this when you reach the lead point for the level off. Reset the power and pitch for level flight, using the altimeter and VVI. Then resume a normal cross-check for straight-and-level flight.

9.6.3. **Constant Airspeed Climbing and Descending Turns.** Simultaneously use the techniques to establish the bank for a level turn and the pitch for a straight climb or descent during the entry to a constant airspeed climbing or descending turn. Level off as in straight climbs and descents.

9.7. **Constant Rate Climbs and Descents.** Initially enter constant rate climbs and descents from level flight, maintaining an airspeed of 160 knots and a vertical velocity of 1,000 fpm. If a change of airspeed is necessary, make the change before starting the maneuver. As proficiency increases, perform rate climbs and descents at different airspeeds, vertical velocities, and configurations.

9.7.1. Constant Rate Climbs. To enter the climb, simultaneously advance power to the approximate climb power setting. Adjust pitch to the proper attitude to maintain airspeed. After the vertical velocity stabilizes, readjust your pitch and rpm as necessary to maintain the desired vertical velocity and airspeed. Maintain heading with the heading indicator. Any deviation from the desired rate of climb on the VVI indicates a need for a change in the pitch attitude. Coordinate pitch and power corrections closely. For example, if the vertical velocity is correct but the airspeed is high, reduce the power. As power is decreased, increase pitch slightly to avoid a decrease of vertical velocity. Level off from a rate climb is the same as level off from constant airspeed climbs.

9.7.2. Rate Descents. The technique and cross-check are exactly the same as those used for climbs. The only differences are the pitch attitude and power setting. Level off from a rate descent is the same as from constant airspeed descents. Rate descents have many practical applications in instrument flight procedures. Radar and ILS approaches require rate descents during the final approach. The precision with which you perform a rate descent could mean the difference between breaking out of a low ceiling and landing or executing a missed approach.

9.8. Instrument Slow Flight. Before performing an instrument approach, you may practice instrument slow flight to become familiar with aircraft handling characteristics. Practice instrument slow flight at airspeeds and configurations specified for an instrument final approach. This exercise may also be used to become familiar with the aircraft handling characteristics during visual straight-ins.

9.9. Vertical-S (A-B-C-D). These maneuvers are designed to improve your instrument cross-check, including pitch, bank, and power control. Procedures for maintaining the descent or climb are exactly the same as those for constant rate climbs and descents. Establish a climb or descent at a rate of 1,000 fpm. Pitch and power coordination are essential. The lead point for a level off from a climb or descent is used as a starting point for the reversal in vertical direction after each 1,000-foot change of altitude. The use of trim increases the ease of aircraft control. A rapid cross-check is necessary during the changes in vertical direction. You must anticipate the need for a power change before reaching the 1,000-foot point because you cannot stop the vertical velocity in an instant. Use power as necessary to maintain 160 knots throughout the maneuver. Accomplish the vertical-

S A,B,C, and D as described in AFM 51-37, paragraph 2-4.

9.10. Confidence Maneuvers. Confidence maneuvers are taught to show that an aircraft can be flown safely through extreme attitudes by reference to instruments. The attitude indicator is the most useful instrument in extreme pitch and bank attitudes. Before performing these maneuvers, check that loose equipment is stowed and ensure the boost pump is operating. If flown in a series, you do not have to check these items between individual maneuvers.

9.10.1. Aileron Roll. With power at 90 percent, lower the nose to attain an entry airspeed of 220 knots. Accomplish the maneuver as described in AFM 51-37, paragraph 2-5b.

9.10.2. Wingover. With power at 90 percent, lower the nose to attain an entry airspeed of 220 knots. Accomplish the maneuver as described in AFM 51-37, paragraph 2-5a.

9.11. Unusual Attitudes. An unusual attitude is any unexpected or inadvertent attitude which is encountered but not required for normal instrument flight. Some possible causes of unusual attitudes are slow cross-check, spatial disorientation, turbulence, transition from VFR to IFR, and extreme attitudes resulting from combat tactics.

9.11.1. Use the attitude indicator as the main recovery instrument after verifying it is operating properly and an unusual attitude exists. Do this by comparing control and performance instruments.

9.11.2. Bank interpretation and control response are most important in recovering from unusual attitudes. In high performance aircraft, an inverted diving attitude is the most critical situation. Proper bank correction to return to right side up is mandatory; you must initiate it before pitch correction. From inverted (beyond 90° of bank) diving attitudes, the aircraft must first be rolled to less than 90° of bank to avoid excessive loss of altitude or exceeding design limits.

9.11.3. From steep climbing attitudes the aircraft must be rolled toward a 90° banked attitude to allow the nose to slice smoothly to the horizon to avoid stalling or negative Gs. By rolling toward the 90° bank attitude, the nose will fall naturally to the horizon and enough back pressure can be held to keep you comfortably in your seat.

9.11.4. The initial recovery is made by referring to the attitude indicator. As long as the horizon bar is visible on the ARU-42A/ARU-44A, similar

indications of attitude can be observed. However, in extreme pitch attitudes, the horizon reference goes out of sight. If the miniature aircraft has a black background, you are diving; a grey background means you are climbing. In other than extreme pitch attitudes, the background coloring and lettering (climb/dive) can be used to determine if you are upright or inverted.

9.11.5. If the aircraft is diving, roll (or continue the roll) toward wings level, adjust power and extend the speed brake as appropriate, and return to level flight. If you are inverted, back pressure will only increase the loss of altitude; therefore, hold only enough back pressure to keep well seated until the bank is less than 90°.

9.11.6. If the aircraft is climbing, use power as required and roll (or continue to roll) to bring the bank pointer toward the nearest 90° bank index mark. Maintain the bank and back pressure to remain well seated. As the fuselage dot of the miniature aircraft approaches the horizon bar, adjust bank to establish a wings-level attitude. Adjust pitch as necessary, depending on airspeed, to regain straight-and-level flight; and complete the recovery with minimum altitude loss. In some cases, recovery can be made before reaching 90° of bank. This recovery is similar to the wingover maneuver.

9.11.7. Recovery from unusual attitudes on partial panel (without the attitude indicator) is an emergency procedure. Refer to AFM 51-37 for this procedure.

9.12. VOR Orientation. Previously, most of your instrument flying has been basic instrument maneuvers. They have been performed with no specific relation to a fixed ground reference. The VOR provides a fixed reference from which these basic maneuvers can be performed in a planned sequence. The maneuvers and procedures explained in the remainder of this chapter are used to arrive at a definite fix and, if necessary, to hold at a fix until the controlling agency can clear you for an instrument approach and landing. Information for operation of the equipment may be found in section one of the flight manual for T-37B aircraft. Procedures for time-and-distance check, homing, course interception, maintaining course, and station passage are in AFM 51-37.

9.13. DME Orientation. Distance measuring equipment (DME) extends the instrument capabilities of the T-37 aircraft by providing continuous slant-range distance information. It also permits position orientation, groundspeed checks, arcing,

proceeding direct to a radial or DME fix (fix to fix), and improved instrument guidance when flying VOR or DME and VOR and tactical air navigation (TACAN) (VORTAC) approaches. Detailed procedures for using the DME are in AFM 51-37. Remember, the distance displayed on the DME indicator is the slant-range distance between the aircraft and a TACAN or DME station, not a VOR station. You are receiving course guidance from one station and DME information from another, but these two stations may or may not be collocated. Instrument approaches using VORTAC, but designated TACAN, should not be flown because the VOR portion has not been flight checked.

9.14. Instrument Departures. Although you are normally provided radar vectors during instrument departures, published standard instrument departures (SID) are usually provided to expedite traffic flow if departure control radar malfunctions. These SIDs afford a safe and fast method for aircraft to transition from the takeoff leg to IFR altitudes and routes. Your IP will have you practice instrument departures during advanced instruments. Normally, you will use tech-order climb during departures, and any intermediate level offs will be flown at the tech-order climb speed for that altitude.

9.15. Holding. Procedures for entering, holding, and leaving the holding pattern are described in flight information publication's (FLIP) General Planning, AFM 51-37, and the flight manual. Use 160 knots for holding at all altitudes. To descend in the holding pattern, adjust the power as required (speed brake optional) and maintain 160 knots.

9.16. Jet Penetrations and Descents. In instrument flying, two methods are used to depart the en route structure and prepare for the final approach and landing. One is the jet penetration, which uses a published descent specifying altitudes and courses. The other is the en route descent, which is not published but is requested from the controlling agency. The pilot decides to use one or the other based on many factors.

9.16.1. Penetration:

9.16.1.1. Entry airspeed for penetration will depend on whether penetration is started on station passage from en route cruise or a holding pattern. If holding is not required, reduce to penetration airspeed or below before crossing the initial approach fix (IAF). If holding is required, entry airspeed is holding pattern airspeed.

9.16.1.2. Complete the descent check before departing the IAF. Also, ensure you are familiar with the minimum and emergency safe altitudes, field elevation, and other recovery information (weather, altimeter setting, type of approach, etc.).

9.16.1.3. To initiate the penetration, simultaneously reduce power to 65 percent and lower the nose of the aircraft to approximately 10° nose low on the attitude indicator until the airspeed approaches 200 knots. Then extend the speed brake. Trim to relieve pressure during this procedure and maintain 200 knots. Another option is to use idle power, no speed brake, and maintain approximately 10° nose low. Use the speed brake to prevent exceeding 250 knots below 10,000 feet MSL. If a penetration turn is required, use 30° of bank. However, you may decrease bank to keep from undershooting the inbound course.

9.16.1.4. Monitor the altitude carefully during penetration. Because of the high rates of descent associated with this phase of flight, you can easily misjudge the altitude and misread the altimeter. Carefully cross-check all needles and counterdrums on the altimeter to prevent misreading the instrument by 1,000 or 10,000 feet, the two most common errors.

9.16.1.5. You may want to decrease the rate of descent as you approach level off altitude. To do so, decrease the pitch attitude and allow the airspeed to decrease. When you reach a normal lead point for level off, smoothly adjust the pitch to level flight and adjust power and speed brake. If you need to slow to gear-lowering airspeed immediately after level off, leave the speed brake extended (if desired).

9.16.1.6. Refer to AFM 51-37 for procedures for intercepting inbound courses. The T-37 flight manual contains recommended single-engine procedures. DO NOT transmit the gear down call until the gear is DOWN AND LOCKED. During normal teardrop VOR penetrations, use the above procedures which are designed to comply with descent gradients and altitude restrictions. They will allow you to remain within the specified distance from the facility. During penetrations that use DME, you may alter these procedures as necessary to comply with altitude restrictions.

9.16.2. En Route Descent. You will frequently use an en route descent instead of a published penetration from an en route altitude to a final approach fix (FAF). It is a simple procedure which expedites air traffic movement. Airspeed, power settings, and speed brake are optional during an

en route descent. Vary their use to comply with controller instructions. Fuel consumption is an important planning consideration. Refer to AFM 51-37 for specific instructions regarding this type of instrument descent. Before performing an en route descent, make sure you are familiar with the minimum and emergency safe altitudes, field elevation, lost communication procedures, and other associated recovery information.

9.17. Final Approach. The en route descent or penetration from en route altitude will lead you to an instrument approach procedure. These approaches are found in FLIP or your local in-flight guide. AFM 51-37 has basic procedures for all types of approaches. Reference the T-37 flight manual for emergency procedures.

9.17.1. The airspeed for all instrument final approaches (other than crosswind or emergency conditions) is 110 knots. Configuration is landing gear, landing lights, and 50 percent flaps down with speed brake optional. Configure, slow to 110 knots, and complete the before-landing check before initiating the final approach part of the approach procedure. This is before glide path interception on precision and visual approaches and before the FAF on nonprecision approaches. With crosswind or gusty wind conditions, configure using flap settings and airspeeds used on final during contact conditions. (For configuration purposes, the FAF on an airport surveillance radar (ASR) approach is the point at which the controller directs descent to the minimum descent altitude (MDA).)

9.17.2. The transition to landing phase begins when visual contact is made with the runway environment. You may maintain the instrument glide path to landing or transition to a visual glide path such as the VFR overhead pattern. In either case, you have the option of extending the speed brake and (or) lowering full flaps when the situation warrants. When lowering flaps to 100 percent, slow to 100 knots.

9.17.3. In lower ceiling and visibility situations, be sure to establish adequate visual references with the runway environment before transitioning to a visual glide path. Do not duck under or set up a high sink rate which will result in a short or hard landing. See AFM 51-37 for further information on "duck-unders" and illusions during instrument transitions to landing.

9.18. Circling Approach. A circling approach is a visual flight maneuver flown at the completion of an instrument approach to align the aircraft

with the landing runway. Use it when conditions such as wind, runway closure, etc., rule out a straight-in approach. Many variables exist in executing a circling approach. Consider airfield obstructions, weather, aircraft turning performance, and cockpit visibility in your preflight planning.

9.18.1. While maneuvering at circling MDA, the visual cues for runway displacement will be considerably different than those commonly used in the overhead pattern. Because the circling approach is generally flown at a lower altitude than the overhead pattern, proper displacement will appear to be much wider than normal. A technique that works well when circling at approximately 500 feet AGL is to put the wingtip on the landing runway. Remember to compensate for the existing winds and avoid excessive bank and back pressure. If any unfavorable situation develops during the approach, don't compromise safety; initiate an immediate go-around or missed approach.

9.18.2. Fly circling approaches at 110 knots with half flaps, gear, and landing lights. Extend the speed brake and additional flaps on base leg or final, if desired. Maintain 110 KIAS on base and final. If visibility permits, attempt to establish a normal final approximately 1/2 mile from the runway. (Slow to 100 knots on final if full flaps are used.) Additional procedures for executing a circling approach are in AFM 51-37 and the T-37 Dash I.

9.19. **Landing.** The primary purpose in performing any instrument approach is to land. The transition from instrument to visual references to complete the landing is critical. AFM 51-37 contains information about landing from instrument approaches which you must completely understand. You may elect to increase the flap setting and lower the speed brake when transitioning to a visual glide path for the landing.

9.20. Missed Approach:

9.20.1. Execute a missed approach any time you cannot complete a safe landing from an instrument approach. Advance the throttles to military, and retract the speed brake. Establish a climbing attitude on the attitude indicator that is 5° above your existing level-flight reference. Cross-check the VVI and the altimeter for climbing indications. When definitely climbing, raise the gear and flaps and turn off the landing lights. If an immediate turn is necessary, ensure you have a safe airspeed.

9.20.2. Ensure a positive climbing attitude is maintained. When the airspeed reaches 160 knots,

adjust the power and the pitch as required. Maintain a constant airspeed climb until reaching missed approach altitude. Cross-check all instruments to ensure the proper heading and climb are maintained. Level off and maintain a minimum of 160 knots if successive approaches are desired or accelerate to tech-order airspeed if diversion is necessary. Follow the missed approach procedure until you have coordinated for another clearance; then follow all instructions given by approach control or ATC.

9.21. **Voice Procedures.** Air-to-ground communication is almost wholly dependent on use of the voice. Control of air traffic locally and along the airways is predicated entirely upon voice communication. With the ever-increasing amount of air traffic, there is a corresponding increase in the number of voice transmissions required to control the traffic. Good voice procedures, therefore, are not merely desirable, but mandatory. Refer to FLIP General Planning for voice procedures, position reporting, and phrasology.

9.22. **Spatial Disorientation Maneuvers.** The spatial disorientation maneuvers listed below have been selected because of their relation to normal instrument or turbulent flight. These maneuvers should be simulated and practiced only under direct supervision. More violent and prolonged maneuvers may have a disorienting effect. However, they are not the type of maneuver or situation likely to be inadvertently encountered. To understand spatial disorientation, carefully study AFM 51-37, attachment 2.

9.22.1. Sensation of Climbing While Turning:

9.22.1.1. **Demonstration.** This sensation can be induced by having the pilot's eyes closed while the aircraft is in a straight-and-level attitude. With a relatively slow entry, the supervisory pilot should execute a well-coordinated 90° turn, using about 1 positive G. While the aircraft is turning under the effect of positive G and with the pilot's eyes still closed, the supervisory pilot should ask the pilot's impression of the aircraft attitude. The usual sensation is that of a climb.

9.22.1.2. **Correlation under actual instrument conditions.** If the aircraft enters a slight, coordinated turn in either direction while the pilot's eyes are diverted away from the instruments, the sensation of a nose-up attitude may occur. If the angular acceleration in the turn is too little to stimulate the inner ear, the change in G force caused by the turn is the only sensation perceived. Positive G is usually associated with a climb; negative G with a dive or nose over.

9.22.2. Sensation of Diving During Recovery From a Turn:

9.22.2.1. **Demonstration.** This sensation can be created by repeating the turning procedure described in paragraph 9.22.1 except the pilot keeps his or her eyes closed until the recovery from the turn is approximately one-half completed. While the recovery is being executed and with the pilot's eyes still closed, the supervisory pilot should observe the pilot's impression of the aircraft attitude. The usual response is that of the aircraft descending.

9.22.2.2. **Correlation under actual instrument conditions.** If the pilot's eyes are diverted from the instruments during a turn under instrument conditions, a slow recovery will cause the body to perceive only the decrease in positive G force. This sensation causes the pilot to believe the aircraft has entered a descent.

9.22.3. False Sensations of Tilting to Right or Left:

9.22.3.1. **Demonstration.** This sensation may be induced from a straight-and-level attitude with the pilot's eyes closed. The supervisory pilot should maintain wings level and use the right rudder to produce a slight skid to the left. The usual sensation is that of being tilted to the right.

9.22.3.2. **Correlation under actual instrument conditions.** If the pilot's eyes are momentarily diverted from the instruments as a skid to one side occurs, a false sensation of tilting the body to the opposite side may occur.

9.22.4. False Sensation of Motion Reversal:

9.22.4.1. **Demonstration.** This false sensation can be induced from a straight-and-level attitude with the pilot's eyes closed. The supervisory pilot should roll the aircraft at a constant rate of 1° to 2° per second to a 30° to 45° bank angle. The roll should be stopped abruptly and the bank attitude held. The usual reaction is a sense of rapid rotation in the opposite direction.

9.22.4.2. **Correlation under actual instrument conditions.** If the aircraft rolls or yaws with an abrupt stop while the eyes are diverted from the

instruments, a sensation of rolling or yawing to the opposite direction may occur. Therefore, the natural response to this false sensation would result in a reentry or an increase of the original roll or yaw. This response is a common error in rolls or spins when the visual references are poor. The sense of sight is the only sense that should be relied upon for correct recovery techniques.

9.22.5. Sensation of Climbing:

9.22.5.1. **Demonstration.** This maneuver may be demonstrated by starting from a straight-and-level flight attitude at the aircraft's normal final approach airspeed; then adding power and accelerating straight ahead. The supervisory pilot should ask the pilot (whose eyes are still closed) what the sensation is of the aircraft's attitude. The usual sensation perceived without visual reference is that of the aircraft climbing.

9.22.5.2. **Correlation under actual instrument conditions.** This sensation may be very strong during an instrument missed approach. The false sensation of an excessive climb is produced by the change in aircraft attitude and acceleration. This sensation may occur before the climb and after level off.

9.23. Conclusion. This chapter ties together the reasons for all of the previous basic instrument maneuvers. Actual instrument flying is nothing but a series of basic instrument maneuvers flown in a sequence depending on the route flown, weather, air-traffic congestion, etc. You should be able to make an ITO and a tech-order climb to altitude and navigate from one fix to another, using VOR or DME equipment. On arriving at your destination, you should be able to hold or, when cleared, penetrate, make an approach, and land at the airport. The power settings in table 9.1 are approximate; use them as a guide. They will vary with fuel load, temperature changes, and different aircraft. For power settings for air work at altitudes other than 15,000 feet, add 1 percent per 1,000 feet above 15,000 or subtract 1 percent per 1,000 feet below 15,000 feet. Some aircraft may not be able to reduce to low rpm at high altitude because of barometric restriction in the fuel control.

TABLE 9.1

T-37 INSTRUMENT FLYING AIRSPEEDS AND POWER SETTINGS

LINE	A	B	C	D
	Procedure	Airspeed (Knots)	Approximate Percentage of rpm	Configuration
1	Takeoff	NA	(military)	gear, 50-percent flaps
2	Climb	tech-order climb		clean
3	High cruise, 15,000 feet	190	87	clean
4	Normal cruise, 15,000 feet	160	81	
5	Slow cruise, 15,000 feet	140	78	
6	1,000 fpm climb, 15,000 feet	160	93	
7	1,000 fpm descent, 15,000 feet		57	
8	Downwind leg		73	
9	Base leg	120	78	gear
10	Final approach (level flight)	110	82	gear, one-half flaps
11	Precision final approach (500 fpm/descent)		70	
12			74	gear, speed brake, one-half flaps
13	Nonprecision final approach (1,000 fpm/descent)		65	gear, one-half flaps
14			70	gear, one-half flaps, speed brake
15	Missed approach	160	(as desired)	clean

Chapter 10

NAVIGATION

10.1. Introduction. This chapter is a short review of navigation techniques and is not intended to replace a thorough knowledge of ATCP 51-16.

10.2. Preparation for Flight. Navigation is an integral part of flying and a culmination of knowledge and skills you have learned in academics and other phases of training. Thorough preflight planning is the key to a successful navigation flight. Preparations for the flight may actually begin days before departure. You can select the base and route early, leaving the wind computations, fuel requirements, and weather conditions until just before filing the required flight plan. Remember that the publications normally carried on the aircraft are for the local flying area. Your planned route or a possible weather divert may take you to an area not covered by these local publications so you should obtain other publications before departing the home field.

10.3. Preflight Planning:

10.3.1. Plan your flight at optimum altitudes and airspeeds consistent with mission requirements, safety, and sound flight planning. Include a review of airfields en route for possible emergency or diversion use. A good technique is to circle these fields on your map for ready reference in flight. These emergency airfields should be compatible with T-37 landing requirements.

10.3.2. Carefully examine the aircraft-servicing capabilities of your destination and alternate airfields. Some aircraft transient maintenance personnel, particularly at non-Air Force installations, may not be totally familiar with T-37 servicing procedures. Refer to the strange-field procedures section of your flight crew checklist for proper fuel, oil, hydraulic fluid, oxygen, and tire pressure requirements. If you have any doubts about the ability of transient maintenance to properly service your aircraft, check with your SOF before filing your flight plan.

10.3.3. When completing takeoff data, variables such as pressure altitude, temperature, and runway data can cause major deviations from the computations associated with home field operations.

10.4. Ground Operations. Ensure transient alert personnel are familiar with starting and poststarting procedures. Before starting engines, confirm the status of your clearance with ground control

or clearance delivery. If you anticipate any delay, do not start engines until clearance is received. After receiving your air traffic control clearance, check it against your original plan to be sure you can comply with changes.

10.5. Departure. Before takeoff, plan for departure by reviewing departure routing and altitude restrictions. Air traffic control may change your clearance by giving you radar vectors, changes in altitude, or changes in route of flight. The better your preflight plan, the easier you can handle these changes. At level off, make a comparison of aircraft position and fuel remaining against the preplanned position and fuel. Any significant deviations may require a change of flight plan.

10.6. En Route:

10.6.1. Outside the local training environment it is very easy to forget the required in-flight checks. The same checks are required; only the location has changed.

10.6.2. Once you have reached cruise altitude and set the power to maintain your preplanned airspeed, you may want to perform a groundspeed check. Compare your actual groundspeed to the preplanned computations to determine the effects of actual wind. When crossing the checkpoints, compare your fuel and time to the preplanned computations. A significant deviation may require a change in the flight plan.

10.6.3. A good technique is to write down assigned radio frequencies. This will aid you if contact is not made on the next assigned frequency. Return to the previous frequency, and confirm the new frequency when necessary.

10.6.4. Maintain a constant awareness of position through the use of NAVAIDs, map reading, and dead reckoning (DR). A radio or NAVAID failure can occur at any time.

10.7. Arrival and Landing. Refer to chapter 9 of this manual and AFM 51-37 for the descent and instrument approach. Determine what type of approach to expect at the destination before you commit yourself. Some approaches require extensive cruise at lower altitudes which may not be desirable because of excessive fuel consumption. From this planning, you should be familiar with airfield layout, approach lighting, type of glide path guidance, field elevation, runway data, tower and ground control frequencies, etc. Wide runways

(more than 150 feet) may contribute to high flares and dropped-in landings. Narrow runways may cause late or incomplete flares and hard landings.

10.8. After Landing:

10.8.1. After engine shutdown, complete the before-leaving-aircraft checklist and conduct a thorough postflight inspection of the aircraft. Ensure transient maintenance personnel are thoroughly familiar with all servicing requirements, as outlined in the strange-field procedures section of the flight crew checklist. Be sure the aircraft will be properly secured.

10.8.2. Tell transient maintenance how to contact you should any questions arise or unusual situations be encountered after you leave the aircraft. Remember, the aircrew is ultimately responsible for the aircraft until it is returned to the home station. Even after careful preflight planning, unforeseen circumstances may result in degraded transient servicing capability such as absence of proper servicing fluids and (or) equipment. If any doubt exists as to transient maintenance's ability to properly and safely service your aircraft, contact your SOF before any servicing is begun.

10.9. Low-Level Navigation on Military Training Routes (MTR). The purpose of low-level navigation is to fly a selected ground track and arrive at a designated target at a designated time over target (TOT). Low-level flying requires extensive preflight planning to ensure flight safety and maximum training from each sortie.

10.9.1 Preflight Coordination. The first step in preparing for low-level missions is to become completely familiar with the route requirements and applicable publications (FLIP AP/IB, ATCP 51-16 (chapters 5 and 8), and the chart update manual (CHUM)).

10.9.2. Mission Planning:

10.9.2.1. Select a groundspeed that is easily converted to miles per minute but allows for required airspeed corrections, that is, 180, 210, or 240 knots. Reference the flight manual charts for the required fuel flow for the planned true airspeed.

10.9.2.2. During premission planning, check the forecast weather for the route. Use the forecast temperature, pressure altitude, and winds to compute the indicated airspeeds required for the planned groundspeed.

10.9.2.3. Fly low-level navigation at an altitude of 500 to 1,500 feet AGL. When terrain height varies, maintain a minimum of 500 feet above the highest terrain within 2,000 feet of the aircraft. Towers and other man-made obstacles are more difficult to see than high terrain; therefore, fly a minimum of 500 feet above the highest obstacle within 2 NM of the aircraft. Once the obstacle is acquired visually and positively identified, the 2,000-foot clearance applies.

10.9.2.4. To minimize the possibility of a bird strike and avoid the problems associated with visual illusions, enter the route no earlier than 1 hour after sunrise and exit the route no later than 1 hour before sunset.

10.9.3. Route Development:

10.9.3.1. Use a 1:500,000 scale map (tactical pilotage chart (TPC)) when flying low levels or VFR legs below 5,000 feet AGL. You may also use a 1:250,000 scale map (joint operations guide (JOG)) on low-level routes.

10.9.3.2. After drawing the route corridor, update the chart with the latest information from the CHUM. This step is imperative for flight safety. Next, study the route corridor to identify all significant obstacles and high terrain.

10.9.3.3. Select a target and easily recognizable turn points for navigation. The best features for turn points are usually natural (as opposed to manmade) because natural features seldom change. Choose these turn points for uniqueness, vertical development, funnelling features, and surrounding terrain. Avoid using a feature that may be hidden by high terrain or trees.

10.9.3.4. Choose an initial point (IP) about one to three minutes from the target. An IP is an easily identifiable point used to fine-tune navigation and increase the probability of target acquisition. Minimize the heading change at the IP in order to increase the accuracy of the IP-to-target leg. If the IP is positively identified, normally restart the clock at the IP. If the IP is not positively identified, restart the clock on time.

10.9.3.5. The start point must be within the route corridor, but does not necessarily have to be at the published entry point. When picking turn points, consider the turning room required to remain within the route corridor. Remain clear of any FLIP-directed, noise-sensitive areas or airfields. Wherever possible, choose easily identifiable points along the route to update and fine-tune course navigation. Where no such points exist, rely solely on DR.

10.9.3.6. A thorough and detailed map study is

essential after developing the route. Reading the shape of the land from the map is also important. A JOG may initially help you interpret data if you are using a TPC. Try to visualize all the key points on the route, and the general features around them, so that you can minimize reference to the map while airborne. Funnelling features such as converging ridge lines, rivers, and roads are especially helpful in locating selected points.

10.9.4. Map Marking. In addition to the information required in ATCP 51-16, you should make the following marks (or computations) on your map:

10.9.4.1. Draw in the MTR corridor from entry to the planned exit point. Circle turn points to prevent masking critical details.

10.9.4.2. Draw turn circles based on the planned groundspeed and bank angle. Use a tactical plotter, if available, or refer to AFM 51-37, chapter 7, for aircraft turn performance.

10.9.4.3. Draw and label timing lines along the planned ground track. A one or two minute interval is sufficient.

10.9.4.4. Draw information boxes aligned with each leg which include heading and any other relevant information.

10.9.4.5. Highlight any obstacles or high terrain features which may be a factor along the route.

10.9.4.6. Compute a continuation fuel for the start point and other selected points along the route. Continuation fuel is the minimum fuel required to complete the route at planned speeds and altitudes and to return to base with AFR 60-16 fuel reserves.

10.9.4.7. Compute a bingo fuel, which includes the required minimum AFR 60-16 fuel reserves for return to base by the most practical means from the most distant point on the route. Factors such as cloud ceilings, winds, freezing level, and forecast icing must be considered when calculating the bingo fuel.

10.9.4.8. Compute and clearly annotate a route abort altitude for the low-level route. This altitude will provide 1,000 feet of clearance (2,000 feet in mountainous terrain) from the highest obstacle within 10 NM of the planned course.

10.9.4.9. Annotate the map with emergency and alternate airfield locations and information necessary to expedite an unplanned divert.

10.9.4.10. Plan the routing to and from the low-level route. Look for points that may help identify

the start point. Ensure each map has identical turn points, IPs, targets, headings, and times.

10.9.5. Flying the Route. If the mission is planned properly, flying accurate headings and airspeeds on each leg will get you close to your turn points, IP, and target. Rely on DR.

10.9.5.1. If the MTR is close to your base and departure procedures allow DR to the entry point, fly your planned headings, airspeeds, and times from takeoff to the entry point. On routes that are a long distance away or at bases that require extensive IFR vectoring prior to route entry, find a point en route at which you can begin DR. In either case, a VOR radial/DME is an excellent way to confirm an entry point.

★10.9.5.2. Before arriving at the entry point, compare the RMI and J-2 heading with the magnetic compass to ensure accuracy. Identify the point as early as possible, and maneuver the aircraft to overfly the entry point on the correct heading. Once inside the route structure, accelerate to the preplanned airspeed. Start your stop watch as you pass the start point.

10.9.5.3. Do not continuously map read because this will jeopardize safety and may lead to misidentifying points. Instead, use selective map reading by only looking for prominent points along the route. Look for points that are 30 seconds to 1 minute ahead of the aircraft; avoid looking at points behind the aircraft. Trimming the aircraft and setting the proper fuel flow or power setting for the planned groundspeed can greatly aid low-level navigation by providing a stable platform. As much as possible, keep your head out of the cockpit. Clearing is essential at low level. When looking at the map, do not look into the cockpit. Raise the map so some forward clearing still exists, but never totally block forward vision with the map. Make corrections as necessary to get back onto track and time, but avoid excessive changes if possible.

10.9.5.4. As much as possible, assess the height above the ground visually. Occasionally cross-check the altimeter against the known elevation of towers, lakes, airfields, or peak elevations.

10.9.5.5. Develop a work cycle for performing cockpit duties, assessing altitude, and updating aircraft position. Identify a turn point as early as possible, and review the next heading and airspeed. If you are unable to acquire the turn point, do not panic. Turn on time, and then try to analyze the reason for not seeing the turn point. Attempt to confirm position with other features. Remember, throughout the route 500 feet AGL

is a minimum altitude. Do not exceed the aircraft commander's comfort level in an attempt to fly at 500 feet. An unfamiliar route, poor visibility, a mountainous terrain, or a number of other factors may require a higher altitude for a reasonable level of comfort.

10.9.5.6. Turns at low altitude require extra emphasis in clearing and aircraft control. Clear in the direction of turn; then roll to the planned bank angle and use back pressure and power as required to maintain altitude and airspeed. Cross-check pitch and bank closely, using outside references to preclude a descent and ensure proper clearing.

10.9.5.7. Arrive over the IP as close to possible to your planned time. Make small corrections as early as possible to prevent large airspeed changes later.

10.9.5.8. Avoid becoming complacent during the return to base. Give the return leg the same emphasis as the route entry leg.

10.9.6. Mountainous Terrain. Flying low level in an environment with rapidly changing terrain is demanding and requires constant positional and situational awareness. Realize that low-lying check

or turn points can easily be hidden when off the planned track. Be alert for areas of turbulence on the downwind side of large features, and fly upwind of ridges whenever possible. To fly safely over high terrain features, begin the climb early enough to arrive at the desired AGL altitude at least 2,000 feet prior to the high terrain. Very large altitude increases may warrant calculation of a start climb point to ensure minimum clearance is maintained. When descending, use an appropriate power reduction to control airspeed.

★10.9.7. thru 10.9.9. (Deleted)

★10.9.10. Conclusion. Flying jet aircraft on low-level missions is a deadly serious business. You are flying at high speeds close to the ground in a high-threat environment. The threat is not enemy aircraft or air defense weaponry, but it is just as real and more deadly (the ground has a 100 percent probability of a kill). Remember, your margin for error and your time to react are greatly reduced due to the close proximity of the ground. Thorough preflight planning and preflight briefings are imperative for safe and effective low-level training. As a minimum, use the low-level navigational briefing guide in AETCI 11-201.

Chapter 11

SPIN TRAINING PROGRAM

11.1. Purpose. The spin training program should focus on increasing the IP's understanding of the T-37 spin characteristics and the aircraft's reaction to changes in the position of the rudder and elevator. The spin training program should comply with chapter 5, this chapter, and AETCR 55-37.

11.2. Spin Demonstration Sortie. The spin demonstration sortie will be flown by the wing spin pilot with qualified pilots only. This sortie is designed to allow the pilot to practice the demonstrated maneuvers during flight as necessary to ensure complete understanding of aircraft reaction in each maneuver performed. If time and fuel permit, the pilot should perform and instruct a spin prevent and a spin recovery.

11.2.1. Prior to the sortie the pilot should review the following:

11.2.1.1. Spin entry procedures and spin restrictions.

11.2.1.2. Spin prevent procedures and spin recovery procedures. CH-2

11.2.1.3. T-37 spin characteristics.

11.2.1.4. Aircraft reaction to changes in the position of the rudder and elevator.

11.2.1.5. Conditions encountered through improper application and handling of the controls during entry, in the spin, and during recovery.

11.2.1.6. Weather conditions affecting spin training.

11.2.2. The ground briefing prior to the sortie should include the following:

11.2.2.1. Objectives of the flight.

11.2.2.2. Details of each maneuver to be accomplished and the sequence in which each maneuver will be performed.

11.2.2.3. An explanation of the expected reaction in each of the demonstrations.

11.2.2.4. Emphasis on the fact that although some of the demonstrations will result in recovery, they will not always be successful and should not be used as normal methods of recovery.

11.2.3. Fly the demonstration in the following sequence:

11.2.3.1. Stability demonstration. This maneuver

demonstrates the aircraft will not enter a spin unless it is in an aggravated stall. Fly the aircraft out of airspeed in a nose-high pitch attitude.

11.2.3.2. Attempted neutral control recovery. This maneuver demonstrates that after the aircraft has entered the spin, neutralizing the controls may not effect a recovery. Enter a spin and place the controls in the neutral position after rotation begins, but before the aircraft has progressed into a fully developed spin. In most cases, neutral control position will not overcome the momentum built up during entry and the aircraft will not recover. When neutral controls fail to effect recovery, the nose of the aircraft remains below the horizon and rotation stabilizes at an increased rate due to insufficient control application. These characteristics are similar to those that occur during a missed spin prevention. When this occurs, perform a spin recovery.

11.2.3.3. Attempted slow prevention. This demonstration shows the amount of control deflection necessary for recovery and the high rotation rate encountered when the spin prevention procedure is incorrectly employed after the spin has developed. Enter a spin. As soon as it develops, apply spin prevention controls very slowly. Notice the amount of control deflection, time required, high rotation rate, and large altitude loss prior to the recovery. If full antispin controls have been applied and the rotation stabilizes at an increased rate, perform a spin recovery.

11.2.3.4. Attempted stick-only recovery. This demonstration shows the effect of the elevator on pitch attitude and illustrates how the stick should be applied during a spin recovery; that is, abruptly. This maneuver also demonstrates that neutral rudder is partially effective against the spin. Enter a spin and hold the prospin rudder until stabilization occurs; then neutralize the rudder. Immediately after the rudder has been neutralized, abruptly apply full forward stick and hold until the nose pitches down near the vertical. The increased time required to reach the recovery attitude is due to the flatter pitch attitude and decreased control effectiveness when forward stick is first applied. The rotation rate increases as the nose pitches down. Then it decreases and stops as the stall is broken. Neutralize the controls and fly out of the ensuing dive. If the spin continues, perform a spin recovery.

11.2.3.5. Rudder reversal. This demonstration shows the reaction of the aircraft to rudder application during the spin. Do not reverse rotation during the demonstration. Enter a spin and hold the pro-spin rudder until stabilization occurs. Apply full rudder opposite the direction of spin while holding the stick full aft. Notice that this results in a lowering of the nose and a momentary increase in the rate of rotation, followed by a marked decrease as the rudder becomes effective. At this time, apply full pro-spin rudder. Due to the sudden change from anti-spin rudder and corresponding reduction in effective surface area of the rudder, the nose rises and the rate of rotation rapidly returns to a stabilized rate. To recover from the demonstration, perform a spin recovery.

11.2.3.6. Attempted wrong-rudder recovery. This maneuver demonstrates control effect and stick pressures resulting if the wrong rudder is used to attempt recovery. Enter a developed spin and initiate a spin recovery, but use the pro-spin rudder. Note that the nose rises slightly after rudder is applied. One turn later, move the stick briskly forward as for normal recovery, and hold. As the stick is moved, note the nose pitch (down), increased rotation rate, and heavy pressure on the stick. With the controls in this position, the spin stabilizes in a slight nose-low accelerated mode and, under most conditions, recovery will not occur. To recover, perform a spin recovery.

11.2.3.7. Rudder effect—attempted rudder-only recovery. This maneuver demonstrates the effect rudder has on pitch attitude and rate of rotation when the stick is released in the spin. Enter a spin and hold the pro-spin rudder until stabilization occurs, then release the stick. Note that the stick stays full back. Neutralize the rudder and note that the nose lowers, the stick moves forward slightly, and the rate of rotation increases. Apply the pro-spin rudder briskly. Note that the nose rises slightly as the stick moves to the full aft position and the rotation decreases. Briskly apply the full anti-spin rudder. The nose will lower, the stick will move forward, and the rate of rotation will increase, decrease, and then stop as the stall is broken. If the rotation continues, perform a spin recovery.

11.3. Spin Checkout Program. Spin pilots will complete the spin checkout program prior to conducting any spin demonstration sorties. The chief wing spin pilot will:

11.3.1. Maintain a folder for each spin pilot to include the following:

11.3.1.1. ATC Form 875, Spin/Stall Pilot Qualification and Evaluation Certification, to log

ground, flight training, and spin pilot evaluation.

11.3.1.2. ATC Form 803A, Student Activity Record, to record comments on the student's progress after each spin pilot qualification sortie.

11.3.2. Conduct spin IP qualification on a proficiency advancement basis:

11.3.2.1. In ground training, students will review spin information contained in the following material:

11.3.2.1.1. G-1-1—T-37 Flight Manual.

11.3.2.1.2. G-1-2—AETCR 55-37 and this manual.

11.3.2.1.3. G-1-3—T-37 PIT Applied Aerodynamics.

11.3.2.1.4. G-1-4—other information as determined locally.

11.3.2.2. To optimize flight training, qualification rides should be conducted with a minimum of two qualified spin IPs as follows:

11.3.2.2.1. C-10-1—briefed and flown as an introductory spin demonstration sortie by a spin IP.

11.3.2.2.2. C-11-X—the student briefs the proper method for performing each demonstration and flies all demonstrations. Instruction may be practiced.

11.3.2.2.3. C-12-X—student conducts a spin demonstration sortie brief. Student flies demonstrations and practices instruction.

11.3.2.2.4. C-13-X (Spin Pilot Qualification Evaluation)—briefed and flown by student and evaluated by a spin IP for demonstrated effectiveness and instruction accuracy.

11.3.2.2.5. C-14-1—student conducts a spin demonstration sortie while occupying the right seat (left seat for SUNT qualified).

11.3.3. Notify 19 AF/DOV by letter after certification of the new spin IP.

11.4. Spin Education Program:

11.4.1. Spin pilots conduct an annual spin seminar during the first quarter of the calendar year. Attendance is mandatory for all assigned T-37 pilots. Document attendance at the annual seminar, and maintain records for at least 1 year according to AFR 12-50, Volume 2. (Wings determine the most suitable method for documenting.)

11.4.2. Wings may supplement this program by using:

11.4.2.1. Inadvertent spin surveys.

11.4.2.2. Spin rides in addition to those already required by this manual.

11.4.2.3. Increased emphasis on spins during IP continuation training meetings.

11.5. Inadvertent Spin Survey Report:

11.5.1. The operations group commander will send a quarterly T-37 Inadvertent Spin Survey Report (RCS: ATC-DOT (Q) 8901) to 19 AF/DOV by letter within 15 days following the end of each quarter. Negative replies are required. Compile the inadvertent spin data and report to include:

11.5.1.1. The maneuver being flown at the time of the inadvertent spin entry.

11.5.1.2. Category of pilot flying the aircraft (that is, student, IP, or proficiency pilot)

11.5.1.3. Type of mission (dual or solo).

11.5.1.4. Method (spin recovery or spin prevent)

used to recover the aircraft from the spin.

11.5.2. The method of survey is determined locally. However, the survey should include all rated and student pilots flying the T-37. The program should be structured so survey respondents remain anonymous.

11.5.3. For reporting purposes, submit the report any time antispin controls must be applied to recover the aircraft. This does not include preplanned entries applicable to normal student training except those recovery attempts that result in inverted spin entries or missed recovery attempts performed by the IP.

11.5.4. On receipt of all quarterly reports, 19 AF/DOV summarizes and forwards comments to each operations group deputy commander for dissemination to aircrews.

NOTE: The emergency status code for this report is "D" discontinue under emergency conditions. MINIMIZE transmission is not authorized.



JOAN W. BLANKENBEKER, Colonel, USAF
Director of Information Management

HENRY VICCELLIO, JR., General, USAF
Commander

TERMS AND ABBREVIATIONS

AC	alternating current	LOC	loss of consciousness
AGL	above ground level	LOS	line of sight
AOA	angle of attack		
ASR	airport surveillance radar	MDA	minimum descent altitude
ATIS	automated terminal information service	MOA	military operations area
		MSL	mean sea level
CDI	course deviation indicator	MTR	military training route
CHUM	chart update manual		
		NAVAIDs	navigational aids
DC	direct current	NM	nautical mile
DME	distance measuring equipment	NORDO	no radio
DR	dead reckoning	NOTAM	notice to airman
		NWLO/TD	nose wheel lift-off/touchdown
EGT	exhaust gas temperature		
		PIT	pilot instructor training
FAF	final approach fix	psi	pounds per square inch
FCIF	flight crew information file		
FOD	foreign object damage	RMI	radio magnetic indicator
FLIP	flight information publication	rpm	revolutions per minute
fpm	feet per minute	RSU	runway supervisory unit
GND	ground	SID	standard instrument departures
		SOF	supervisor of flying
HCA	heading crossing angle		
HEFOE	hydraulic, electrical, fuel, oxygen, engine	TACAN	tactical air navigation
		TOLD	takeoff and landing data
IAF	initial approach fix	TOT	time over target
IFF/SIF	identification, friend or foe/ selective identification feature	TPC	tactical pilotage chart
		TWR	tower
IFR	instrument flight rules		
ILS	instrument landing system	UHF	ultra high frequency
IMC	instrument meteorological conditions	UPT	undergraduate pilot training
IP	instructor pilot or initial point	VFR	visual flight rules
ITO	instrument takeoff	VMC	visual meteorological conditions
		VOR	very high frequency omnidirectional range
JOG	joint operations guide	VORTAC	VOR and TACAN
		VVI	vertical velocity indicator
KTAS	knots indicated airspeed		

Air Force Functional Doctrine

MISSION EMPLOYMENT

PRIMARY FLYING, T-37

AETCM 3-3, Vol 2, 1 July 1993, is changed as follows:

1. Page-Insert Changes. New or revised material is indicated by a ★.

Remove	Date	Insert
3 thru 6	1 Jul 93	3 thru 6
25, 26	1 Jul 93	25, 26
79 thru 82	1 Jul 93	79 thru 82

2. Write-in Changes:

Page	Reference	Line	Action
2	table of contents, chapter 3	-	Add "Trim Malfunctions3.925"
66	para 8.4	1, 2	Delete "Except for in-flight checks," and capi- talize the word "visual"
66	para 8.4	4, 5	Delete "and its AETC Sup 1."
66	para 8.5.1.2	1	Add the word "call" after "Acknowledge lead's radio"
78	para 8.25	1	Delete
78	para 8.25.1	1 thru 18	Delete
90 thru 95	section D	-	Delete

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HQ AMC/DOTO240



HENRY VICCELLIO, JR., General, USAF
Commander

JOAN W. BLANKENBEKER, Colonel, USAF
Director of Information Management

Air Force Functional Doctrine

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Remove	Date	Insert
1, 2	1 Jul 93	1, 2
3 thru 6	27 Dec 93	3 thru 6
7 thru 12	1 Jul 93	7 thru 12
23, 24	1 Jul 93	23, 24
25, 26	27 Dec 93	25, 26
31 thru 34	1 Jul 93	31 thru 34
37, 38	1 Jul 93	37, 38
51, 52	1 Jul 93	51, 52
55, 56	1 Jul 93	55, 56
63 thru 66	1 Jul 93	63 thru 66
73 thru 80	1 Jul 93	73 thru 80
81, 82	27 Dec 93	81, 82
83 thru 88	1 Jul 93	83 thru 95.3
107, 108	1 Jul 93	107, 108

2. **Write-in Changes:**

Page	Reference	Line	Action
35	para 5.11.1	7	✓Change "wing-level" to "wings-level."
45	para 5.24	3, 4	✓Change "three quarters" to "five eighths."
67	para 8.6	1	✓Change title of para to "Speed Brake Exercise."
109	para 11.2.1.2	1	✓Change "recover" to "recovery."
113 thru 119	Attachments 2 thru 6	—	✓Delete



HENRY VICCELLIO, JR., General, USAF
Commander

JOAN W. BLANKENBEKER, Colonel, USAF
Director of Information Management

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Office/Phone : 19 AF/DOV, DSN: 487-6422

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14OG COLUMBUS AFB MS//CC/CCV//
47OG LAUGHLIN AFB TX//CC/CCV//
64OG REESE AFB TX//CC/CCV//
71OG VANCE AFB OK//CC/CCV//
80FTW SHEPPARD AFB TX//DO/DOV//
Info: ZEN HQ AETC RANDOLPH AFB TX//XOT/XOTI//
ZEN 619TRSS RANDOLPH AFB TX//CC/IDF//
HQ ACC LANGLEY AFB VA//DOVT//

TEXT FOLLOWS

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VOL I

BJ: IMC 96-1 TO MCMAN 11-238 AND AETCM 3-3, VOL II
AF 19AF RANDOLPH AFB TX//DO// MSG 301049Z JAN 96

1. MAKE THE FOLLOWING WRITE-IN CHANGES TO MCMAN 11-238:

A. AFTER PARAGRAPH 6.5.1., ADD NEW PARAGRAPH 6.5.2 TITLED, "RECOVERY SETUP GUIDELINES".

B. ADD THE FOLLOWING TEXT:

6.5.2.1. DURING ANY ABNORMAL FLIGHT RECOVERY SETUP, IP VIGILANCE IS PARAMOUNT. DO NOT COMPROMISE SAFE FLIGHT DURING IP DEMONSTRATION OR STUDENT PERFORMANCE OF RECOVERY TRAINING. IN ALL SITUATIONS WHERE TRANSFER OF AIRCRAFT CONTROL IS INVOLVED, IT WILL BE IAW MCI 11-238, PARA 3.8. TRANSFER OF AIRCRAFT CONTROL.

6.5.2.2. ABNORMAL FLIGHT RECOVERY TRAINING SHOULD BE THOUGHT OF IN THREE PHASES OF PROFICIENCY. THESE PHASES ARE NOT NECESSARILY LINKED TO A PARTICULAR BLOCK OF TRAINING, BUT ARE LINKED TO THE STUDENT'S FLYING ABILITIES AND SITUATIONAL AWARENESS. THESE PHASES ARE:

6.5.2.2.1. INITIALLY, THE IP WILL DEMONSTRATE AND FLY THE COMPLETE SETUP AND RECOVERY WHILE DELIVERING APPROPRIATE VERBAL INSTRUCTION. ONCE THE STUDENT HAS SEEN THE RECOVERY DEMONSTRATED AND A BASIC GRASP OF WHY THE RECOVERY TRAINING IS PERFORMED, THE IP SHOULD BEGIN SETTING UP RECOVERY SITUATIONS FOR THE STUDENT AND TALKING HIM/HER THROUGH THE RECOVERY PROCEDURES.

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6.5.2.2.2. WHEN THE STUDENT SHOWS PROFICIENCY IN THE RECOVERY PROCEDURES, THE IP WILL THEN BEGIN SETTING UP OBSERVABLE SITUATIONS REQUIRING AN ABNORMAL FLIGHT RECOVERY. WHEN THE SETUP IS COMPLETELY DEVELOPED, THE IP WILL TRANSFER CONTROL OF THE AIRCRAFT TO THE STUDENT USING THE VERBAL COMMAND, "YOU HAVE THE AIRCRAFT -- RECOVER." THE STUDENT WILL TAKE THE AIRCRAFT AND RECOVER FROM THE ABNORMAL ATTITUDE.

6.5.2.2.3. ONCE THE STUDENT HAS SEEN ALL THE DIFFERENT TYPES OF SETUPS AND CAN CONFIDENTLY AND PROFICIENTLY RECOVER FROM VARIOUS SITUATIONS, THE IP WILL SET UP THE ABNORMAL FLIGHT RECOVERIES RANDOMLY THROUGHOUT THE AREA PROFILE. ONCE THE SETUP IS COMPLETE, THE IP WILL DIRECT THE STUDENT TO TAKE THE AIRCRAFT WITH, "YOU HAVE THE AIRCRAFT." THE STUDENT WILL TAKE THE AIRCRAFT WITH PROPER TRANSFER PROCEDURES AND RECOVER IN THE APPROPRIATE MANNER.

6.5.2.3. ONCE A STUDENT LEARNS THE CORRECT STICK AND THROTTLE INPUTS, BUILDING THE JUDGEMENT AND ABILITY TO RECOGNIZE ABNORMAL FLIGHT AND RECOGNIZE THE NEED TO ACCOMPLISH AN ABNORMAL FLIGHT RECOVERY BECOMES PARAMOUNT. THE IP SHOULD CONCENTRATE ON DEVELOPMENT OF THE STUDENT'S SITUATIONAL AWARENESS.

C. CHANGE NUMERICAL SEQUENCE OF OLD PARAGRAPH 6.5.2. TO 6.5.3. ALL SUB-PARAGRAPHS WILL BE CHANGED TO REFLECT THE NEW NUMERICAL SEQUENCE.

D. CHANGE NUMERICAL SEQUENCE OF OLD PARAGRAPH 6.5.3. TO 6.5.4. ALL SUB-PARAGRAPHS WILL BE CHANGED TO REFLECT THE NEW NUMERICAL SEQUENCE.

E. CHANGE NUMERICAL SEQUENCE OF OLD PARAGRAPH 6.5.4. TO 6.5.5.

2. MAKE THE FOLLOWING WRITE-IN CHANGES TO AETCM 3-3, VOL II

A. DELETE PARAGRAPH 5.8.2.

B. ADD NEW PARAGRAPH 5.8.2. TITLED, "RECOVERY SETUP GUIDELINES"

C. ADD THE FOLLOWING TEXT:

5.8.2.1. DURING ANY ABNORMAL FLIGHT RECOVERY SETUP, IP VIGILANCE IS PARAMOUNT. DO NOT COMPROMISE SAFE FLIGHT DURING IP DEMONSTRATION OR STUDENT PERFORMANCE OF RECOVERY TRAINING. IN ALL SITUATIONS WHERE TRANSFER OF AIRCRAFT CONTROL IS INVOLVED, IT WILL BE AS PARAGRAPH 1.15 OF THIS MANUAL.

5.8.2.2. ABNORMAL FLIGHT RECOVERY TRAINING SHOULD BE THOUGHT OF IN THREE PHASES OF PROFICIENCY. THESE PHASES ARE NOT NECESSARILY LINKED TO A PARTICULAR BLOCK OF TRAINING, BUT ARE LINKED TO THE STUDENT'S FLYING ABILITIES AND SITUATIONAL AWARENESS. THESE PHASES ARE:

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5.8.2.2.1. INITIALLY, THE IP WILL DEMONSTRATE AND FLY THE COMPLETE SETUP AND RECOVERY WHILE DELIVERING APPROPRIATE VERBAL INSTRUCTION. ONCE THE STUDENT HAS SEEN THE RECOVERY DEMONSTRATED AND HAS A BASIC GRASP OF WHY THE RECOVERY TRAINING IS PERFORMED, THE IP WILL BEGIN SETTING UP RECOVERY SITUATIONS FOR THE STUDENT AND TALKING HIM/HER THROUGH THE RECOVERY PROCEDURES.

5.8.2.2.2. WHEN THE STUDENT SHOWS PROFICIENCY IN RECOVERY PROCEDURES, THE IP WILL THEN BEGIN SETTING UP OBSERVABLE SITUATIONS REQUIRING AN ABNORMAL FLIGHT RECOVERY. WHEN THE SETUP IS COMPLETELY DEVELOPED, THE IP WILL TRANSFER CONTROL OF THE AIRCRAFT TO THE STUDENT USING THE VERBAL COMMAND, "YOU HAVE THE AIRCRAFT -- RECOVER." THE STUDENT WILL TAKE THE AIRCRAFT AND RECOVER FROM THE ABNORMAL ATTITUDE.

5.8.2.2.3. ONCE THE STUDENT HAS SEEN ALL THE DIFFERENT TYPES OF SETUPS AND CAN CONFIDENTLY AND PROFICIENTLY RECOVER FROM VARIOUS SITUATIONS, THE IP WILL SET UP THE ABNORMAL FLIGHT RECOVERIES RANDOMLY THROUGHOUT THE AREA PROFILE. ONCE THE SETUP IS COMPLETE, THE IP WILL DIRECT THE STUDENT TO TAKE THE AIRCRAFT WITH, "YOU HAVE THE AIRCRAFT." THE STUDENT WILL TAKE THE AIRCRAFT WITH PROPER TRANSFER PROCEDURES AND RECOVER IN THE APPROPRIATE MANNER.

5.8.3. ONCE THE STUDENT LEARNS THE CORRECT STICK AND THROTTLE INPUTS, BUILDING THE JUDGEMENT AND ABILITY TO RECOGNIZE ABNORMAL FLIGHT AND RECOGNIZE THE NEED TO ACCOMPLISH AN ABNORMAL FLIGHT RECOVERY BECOMES PARAMOUNT. THE IP SHOULD CONCENTRATE ON DEVELOPMENT OF THE STUDENT'S SITUATIONAL AWARENESS.

3. THIS IS A COORDINATED 19 AF / AETC/XOTI MESSAGE. IMPLEMENT THIS ILC BY FCIF. 19 AF POC FOR T-38 AIRCRAFT IS MAJOR MARK SCHROER, DSN: 487-6422, (E-MAIL: SCHROERM.19AF@SCLAN.AETC.AF.MIL); T-37 POC IS MAJOR GARRY BACCUS AT THE SAME TELEPHONE NUMBER, (E-MAIL: BACCUSG.19AF@SCLAN.AETC.AF.MIL).

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